Issued February 1968

SOIL SURVEY
STARK COUNTY
North Dakota

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION

Major fieldwork for this soil survey was done in the period 1956 to 1961. Soil names and descriptions were approved in 1965. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1961. This survey was made cooperatively by the Soil Conservation Service and the North Dakota Agricultural Experiment Station; it is part of the technical assistance furnished to the Central Stark County and Western Stark County Soil Conservation Districts.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY of Stark County, N. Dak., contains information that can be applied in managing farms, ranches, and windbreaks; in selecting sites for roads, ponds, buildings, or other structures; and in appraising the value of tracts of land for agriculture, industry, or recreation.

Locating Soils

All the soils of Stark County are shown on the detailed map at the back of this survey. This map consists of many sheets that are made from aerial photographs. Each sheet is numbered to correspond with numbers shown on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbol. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units, Capability Units, and Range Sites" can be used to find information in the survey. This guide lists all of the soils of the county in alphabetic order by map symbol. It shows the page where each kind of soil is described, and also the page for the capability unit, woodland group, range site, or any other group in which the soil has been placed.

Individual colored maps showing the relative suitability or limitations of soils for many specific purposes can be developed by using the soil map and information in the text. Interpretations not included in the text can be developed by grouping the soils according to their suitability or limitations for a particular use. Translucent material can be used as an overlay on the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils in the soil descriptions and in the section where the soils are grouped in capability units and range sites.

Foresters and others can refer to the section "Use of the Soils for Windbreaks," where the soils of the county are grouped according to their suitability for trees.

Game managers, sportsmen, and others concerned with wildlife will find information about soils and wildlife in the section "Wildlife."

Ranchers and others interested in range can find, under "Use of the Soils for Range," groupings of the soils according to their suitability for range, and also the plants that grow on each range site.

Engineers and builders will find, under "Use of the Soils for Engineering," tables that give engineering descriptions of the soils in the county and that name soil features that affect engineering practices and structures.

Scientists and others can read about how the soils were formed and how they are classified in the section "Genesis, Classification, and Morphology of Soils."

Students, teachers, and others will find information about soils and their management in various parts of the text, depending on their particular interest.

Newcomers in Stark County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "General Nature of the County," which gives additional information about the county.

Cover picture: Aerial view of a typical farm in Stark County.

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NOTICE TO LIBRARIANS
Series year and series number are no longer shown on soil surveys. See explanation on the next page.

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EXPLANATION

Series Year and Series Number

Series year and number were dropped from all soil surveys sent to the printer after December 31, 1965. Many surveys, however, were then at such advanced stage of printing that it was not feasible to remove series year and number. Consequently, the last issues bearing series year and number will be as follows:

Series 1957, No. 23, Las Vegas and Eldorado Valleys Area, Nev.
Series 1958, No. 34, Grand Traverse County, Mich.
Series 1959, No. 42, Judith Basin Area, Mont.
Series 1960, No. 31, Elbert County, Colo. (Eastern Part)
Series 1961, No. 42, Camden County, N.J.
Series 1962, No. 13, Chicot County, Ark.
Series 1963, No. 1, Tippah County, Miss.

Series numbers will be consecutive in each series year, up to and including the numbers shown in the foregoing list. The soil survey for Tippah County, Miss., will be the last to have a series year and series number.

SOIL SURVEY OF STARK COUNTY, NORTH DAKOTA

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UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION

STARK COUNTY is in the upper part of the Heart River drainage basin in the southwestern part of North Dakota (fig. 1). It has a total land area of 844,160 acres. Dickinson, the county seat, is near the center of the county.

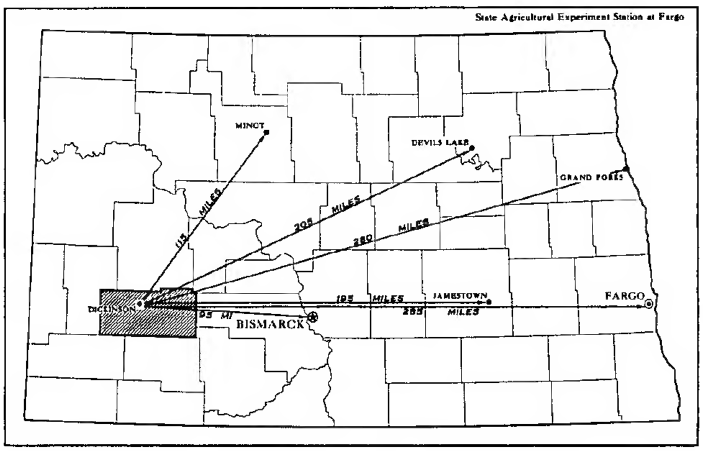

Figure 1.—**Location of Stark County in North Dakota.**

The county consists of a gently sloping to steep upland prairie that is bordered on the west by the Badlands of the Little Missouri River. It has been dissected by the channels of the main streams and by many intermittent waterways. Antelope Creek and the Heart and Green Rivers are the principal streams. There are no other significant natural bodies of water, but many artificial impoundments have been constructed since 1940 to provide water for livestock and recreational purposes. The major impoundment is the Dickinson Reservoir (Edward Arthur Patterson Lake) near the southwestern limits of the city of Dickinson. This reservoir provides water for municipal use and for irrigation, and it also provides facilities for fishing and bathing.

Many of the soils of the county are deep or moderately deep and are well suited or fairly well suited to cultivated crops. The climate is semiarid, however, and conserving moisture is necessary where cultivated crops are grown. Also, some of the soils contain salts or alkali, and most of them are highly susceptible to wind erosion if they are not protected. Wheat is the main crop, but corn, hay, barley, and oats are grown extensively.

The raising of beef cattle is a major enterprise in this county, and a large part of the acreage is in pastures of native and tame grasses. The cattle are sold mainly through local auction markets as feeder calves. A few farmers specialize in dairying. They sell whole milk for local consumption and for use in making cheese at a factory in Lefor.

Only a small acreage is in woods, mainly on bottom lands along the Heart River. Since 1948, increasing numbers of farmstead and field windbreaks have been planted.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in Stark County, where they are located, and how they can be used.

They went into the county knowing they likely would find many soils they had already seen, and perhaps some they had not. As they traveled over the county, they observed steepness, length, and shape of slopes; size and speed of streams; kinds of native plants or crops; kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by roots of plants.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. To use this survey efficiently, it is necessary to know the kinds of groupings most used in a local soil classification.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Morton and Parshall, for example, are the names of two soil series.

All the soils in the United States having the same series name are essentially alike in those characteristics that go with their behavior in the natural, untouched landscape. Soils of one series can differ somewhat in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man.

Many soil series contain soils that differ in texture of their surface layer. According to such differences in texture, separations called soil types are made. Within a series, all the soils having a surface layer of the same texture belong to one soil type. Manning loam and Manning fine sandy loam are two soil types in the Manning series. The difference in texture of their surface layers is apparent from their names.

Some types vary so much in slope, degree of erosion, number and size of stones, or some other feature affecting their use, that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into phases. The name of a soil phase indicates a feature that affects management. For example, Manning fine sandy loam, level, is one of several phases of Manning fine sandy loam, a soil type that ranges from level to sloping.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodland, buildings, field borders, trees, and other details that greatly help in drawing boundaries accurately. The soil map in the back of this survey was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning management of farms and fields, a mapping unit is nearly equivalent to a soil type or a phase of a soil type. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil type or soil phase.

In preparing some detailed maps, the soil scientists have a problem of delineating areas where different kinds of soil are so intricately mixed, and so small in size, that it is not practical to show them separately on the map. Therefore, they show this mixture of soils as one mapping unit and call it a soil complex. Ordinarily, a soil complex is named for the major kinds of soil in it, for example, Chama-Bainville loams, strongly sloping. Another kind of mapping unit is the undifferentiated soil group, which consists of two or more soils not separated on the map, because differences among them are small, their practical value is limited, or they are too difficult to reach. An example is Bainville and Midway soils, steep. Also, on most soil maps, areas are shown that are so rocky, so shallow, or so frequently worked by wind and water that they scarcely can be called soils. These areas are shown on a soil map like other mapping units, but they are given descriptive names, such as Shale outcrop or Wet alluvial land, and are called land types rather than soils.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soils in other places are assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soils. Yields under defined management are estimated for all the soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in a way that it is readily useful to different groups of readers, among them farmers, ranchers, managers of woodland, engineers, and homeowners. Grouping soils that are similar in suitability for each specified use is the method of organization commonly used in the soil survey reports. Based on the yield and practice tables and other data, the soil scientists set up trial groups, and test them by further study and by consultation with farmers, agronomists, engineers, and others. Then, the scientists adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

The general soil map at the back of this report shows, in color, the soil associations in Stark County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of farming or other land use. Such a map is not suitable for planning the management of a farm or field, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect management.

Nine soil associations are in this county. The general location of some of the major soils in the associations and the relationship of these soils to one another are shown in figure 2. The soil associations are described in the following paragraphs.

Deep or Moderately Deep, Nearly Level to Sloping Soils of the Uplands

In this group are three soil associations consisting of deep, nearly level to sloping soils of the uplands. These associations are described in the following paragraphs.

1. Morton-Regent-Grail association

Deep, well-drained, silty or clayey soils

These soils are on uplands that are dissected by swales and drainageways. Their slopes range from 1 to 9 percent. Most of these soils are deep over silty and clayey shale, but steep, shallow Bainville soils, not suitable for cultivation, occupy about 10 to 15 percent of the acreage. The association occupies about 20 percent of the county and is mainly in the south-central and northeastern parts.

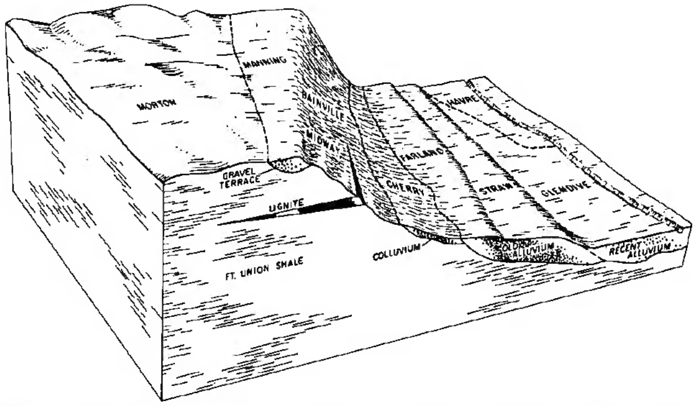

***Figure 2.*—Diagram showing the relationship of some of the major soils in Stark County.**

The Morton soils have a surface layer of very dark grayish-brown silt loam 2 to 8 inches thick. Their subsoil is dark grayish-brown clay loam about 28 inches thick. The Morton soils developed in material weathered from silty shale and loamstone. They are well drained and moderately permeable.

The Regent soils have a surface layer of very dark grayish-brown clay loam or silty clay loam and a subsoil of dark grayish-brown silty clay. Their surface layer and subsoil are similar to those of the Morton soils in thickness. The Regent soils developed in material weathered from clayey shale. Like the Morton soils, they are well drained.

The Grail soils are on the lower upland slopes and in concave drainageways where they receive extra moisture from runoff. They have a darker surface layer and subsoil than the Morton and Regent soils, and their surface layer is also thicker, or 8 to 14 inches thick. This is because the amount of material that is deposited from adjacent areas exceeds that lost through erosion. The Grail soils developed mainly in material washed from adjacent soils underlain by silty and clayey shale.

The soils of this association are susceptible to water erosion. Most of the association is cultivated, however, and good yields of wheat, barley, and oats are obtained. The farms are mainly of the cash-grain and livestock types.

2. *Morton-Vebar-Arnegard association*

Deep, well-drained, loamy and moderately sandy soils

Nearly level to sloping, loamy and moderately sandy soils on uplands and in small drainageways and swales in the uplands make up this association. The soils are deep and well drained. They generally have slopes of 2 to 5 percent, but the range of slope is from 1 to 9 percent. The soils developed in alluvium and in material weathered from loamstone, silty shale, and sandstone. This association occupies about 31 percent of the county and is the largest of the associations. It is mainly in the southern one-fourth of the county and in the central part.

The Morton soils have a surface layer of very dark-brown silt loam 2 to 8 inches thick. Their subsoil is dark grayish-brown loam or clay loam 18 to 42 inches thick. The Morton soils are deep, and they developed in material weathered from silty shale or loamstone. They are well drained and moderately permeable.

The Vebar soils have slopes similar to those of the Morton soils, but unlike the Morton soils, they developed in material weathered from sandstone. They have a surface layer of dark grayish-brown fine sandy loam 5 to 10 inches thick and a subsoil of dark-brown to dark grayish-brown fine sandy loam 20 to 36 inches thick. In places the lower part of their subsoil grades to loamy fine sand.

The Arnegard soils are on the more gently sloping, lower side slopes and in intermittent drainageways where they receive additional moisture in runoff from the higher areas. They have a surface layer of very dark grayish-brown loam and a subsoil of dark grayish-brown loam or light clay loam. Their surface layer and subsoil are thicker than those of the Morton and Vebar soils.

A minor part of this association consists of small areas of shallow, sandy Flasher soils and small areas of steep, shallow, loamy Bainville soils. Also included are areas of sandy Lihen soils that occur with the Vebar soils.

The soils of this association are susceptible to erosion by wind and water. About 70 percent of the association is cultivated, however, and is used to grow small grains and silage corn. The corn often replaces summer fallow in a 2-year rotation. Yields are good to excellent on the Morton and Arnegard soils and fair to good on the Vebar soils.

3. *Promise-Moreau association*

Deep or moderately deep, well-drained, clayey soils

In this association are nearly level soils in upland swales and on valley terraces, and soils of the uplands that have slopes between 2 and 9 percent. The association has a well-defined drainage pattern. Water enters the soils at a moderately slow to slow rate, and much of the water runs off. As a result, most of the soils are slightly to moderately eroded. The association occupies about 4 percent of the county. It is mainly in the southwestern part.

The Promise soils have a surface layer of very dark grayish-brown silty clay 2 to 4 inches thick. Their subsoil is olive-gray silty clay 16 to 25 inches thick. The lower part of the subsoil contains free lime.

The Moreau soils have a surface layer of dark grayish-brown silty clay 2 to 6 inches thick. Their subsoil is dark grayish-brown, dense silty clay or clay 8 to 24 inches thick, and it contains lime and salts. Below the subsoil is bedded shale that is very slowly permeable and restricts the depth to which roots can penetrate. In places the Moreau soils have a thin crust on the surface and have a more grayish color than the Promise soils.

Small areas of Bainville soils that are shallow over loam and clay loam shale are within this association. Also included are areas of shallow rolling to steep Midway soils that have formed in material weathered from silty clay shale.

The soils of this association are susceptible to water erosion. The alternating freezing and thawing in winter make them granulate readily. Then they are susceptible to wind erosion if they are not protected by a cover of plants or plant residue. About 60 percent of the association is used for wheat and barley, and the rest is used mainly for native pasture or tame hay. The principal cropping system consists of alternate summer fallow and

small grains. Yields are good on the Promise soils and fair on the Moreau.

Deep to Shallow, Nearly Level to Moderately Sloping Soils of the Uplands That Have a Claypan and Accumulated Salts

Two soil associations, consisting of nearly level to moderately sloping soils of the uplands, make up this group. These associations are described in the following paragraphs.

4. Rhoades-Promise-Moreau association

Deep to shallow, well-drained, loamy or clayey soils

This association consists of large areas of nearly level to gently sloping soils. The landscape has a scabby appearance because of the many scattered spots that have only a sparse cover of grass. Most of these nearly bare spots are in small pits that are 4 to 10 inches deep. The soils have slopes of 1 to 6 percent. They are deep, moderately deep, and shallow over saline and alkaline shale, and they developed in material weathered from shale or in local alluvium washed from areas underlain by shale. The association is mainly in the extreme western part of the county and makes up about 16 percent of the acreage.

The Rhoades soils, which are shallow over dense, clayey material, occupy 20 to 30 percent of this association. Their surface layer is very dark gray loam or clay loam 2 to 6 inches thick. Their subsoil contains a dense claypan and an accumulation of salts. The texture of the subsoil is generally silty clay.

Promise soils make up 15 to 25 percent of the association. They have a surface layer of very dark grayish-brown silty clay 2 to 4 inches thick and a subsoil of olive-gray silty clay 16 to 25 inches thick. The lower part of their subsoil contains free lime.

The Moreau soils are moderately deep over a layer of dense, clayey material. They have a limy surface layer that has crusted spots in some places. Their surface layer is dark grayish-brown silty clay 2 to 6 inches thick. Their subsoil is limy, dense silty clay or clay that is 8 to 24 inches thick and contains many salt pockets.

Regent and Belfield soils occupy a fairly large part of the association. The Regent soils are mainly in the gently sloping areas. They have a surface layer of very dark grayish-brown silty clay loam 4 to 10 inches thick. Their subsoil is dark olive-gray silty clay 15 to 30 inches thick. The Belfield soils have characteristics of both the Regent and Rhoades soils. The horizons in their profile are similar to those of the Regent soils in color and thickness, and yields are similar to those on the Regent soils. The moderate content of salts in their subsoil is less limiting to the growth of plants than is the large concentration of salts in the Rhoades subsoil.

In places soils of all five of these series occur in an area as small as 1 acre. This pattern of soils may be repeated many times in the same field.

Water erosion is a hazard on this association. The primary management problems are the dense claypan and the high content of salts in the soils. The claypan restricts the amount of water that is taken into the soils, and the salts affect the normal growth of plants.

Approximately one-third of the association is cultivated, and the rest is mainly in native grass. Cultivated crops make poor yields on the Rhoades soils. Small grains make good yields on the Promise soils and fair to good yields on the Belfield and Moreau soils.

5. Belfield-Rhoades association

Deep, well-drained, loamy soils

This association is similar to association 4, but Belfield soils occupy about 35 percent of the acreage, and Rhoades soils about 30 percent. An additional 20 percent is Morton soils, and 15 percent is Vebar soils. The association consists of areas of soils on long slopes of about 2 to 9 percent and of soils in intermittent drainageways that dissect the slopes. Material weathered from loamstone and sandstone occupies the higher, more sloping areas, and the Morton and Vebar soils occur in those areas. The association makes up about 1 percent of the county and is in the north-central part.

The Belfield soils have a surface layer of very dark grayish-brown loamy material 5 to 11 inches thick. Their subsoil is grayish-brown clay loam or silty clay that is free of lime and is 20 to 36 inches thick. Below the subsoil are concentrations of salts.

The Rhoades soils have a surface layer of dark grayish-brown loam, 2 to 6 inches thick, and a dense claypan subsoil, about 15 inches thick. The lower part of their subsoil contains a large amount of salts.

The soils of this association are susceptible to erosion by wind and water. Salinity is a problem on a large part of the association. Some areas, however, are used for crops. Small grains and corn are commonly grown, and yields are fair to good. The farms are mainly of the cash-grain and livestock types.

Deep, Nearly Level Soils on Stream Terraces and Bottom Lands

Two associations, consisting of deep, nearly level soils on stream terraces and bottom lands, make up this group. These associations are described in the following paragraphs.

6. Farland-Havre-Parshall association

Deep, well drained or moderately well drained, moderately sandy or loamy soils

This association consists of soils on nearly level stream terraces and bottom lands adjacent to the Heart and Green Rivers and Antelope Creek. In places the areas have been cut by streambank erosion. The soils are deep and permeable, but they have been slightly to moderately eroded by wind. The association occupies about 6 percent of the county.

The Farland soils have a surface layer of very dark grayish-brown silt loam 3 to 6 inches thick. Their subsoil is nonlimy and is dark grayish-brown clay loam 18 to 32 inches thick. The Farland soils are well drained.

The Havre soils formed in recently deposited loamy alluvium. They consist of alternating layers of loam, silt loam, and fine sandy loam. The Havre soils do not have a distinct boundary between the surface layer and subsoil. They are generally limy throughout the profile and are moderately well drained.

The Parshall soils have a surface layer of very dark brown fine sandy loam, 8 to 18 inches thick, and a subsoil of dark grayish-brown fine sandy loam. Their substratum is sandy and is slightly limy in the lower part. The Parshall soils, like the Farland, are well drained.

Minor soils of this association are the Glendive, Gallatin, and Straw. The Glendive and Gallatin soils are on the lowest part of the flood plains, or first bottoms, and the Straw soil is on slightly higher benches, or second bottoms.

The soils of this association are susceptible to further wind erosion. Cash-grain farming is one of the main farm enterprises, however, and cattle feeding is a second leading enterprise.

The soils of this association are well suited to small grains, corn grown for silage, and legumes. They are near streams, are moderately well drained or well drained, and are nearly level. Therefore, they are well suited to irrigation.

7. *Farland-Savage-Rhoades association*

Deep, well drained or moderately well drained, loamy or clayey soils, some of which have a claypan

This association consists mostly of broad areas of nearly level soils on stream terraces dissected by small intermittent streams. The largest area is in the northeastern corner of the county, within the watershed of the Little Knife River. The association occupies about 3 percent of the county. The soils developed in loamy to clayey alluvium that is more clayey and salty than that in which the soils of association 6 developed.

The Farland soils are deep, well-drained silt loams, and the Savage soils are deep, moderately well drained silty clay loams. The Rhoades soils are shallow over dense, salty, clayey material. Where the Rhoades soils are cultivated, their surface layer is gray and crusted. Where they are in native grass, the areas have a pitted microrelief.

Belfield soils are also common in this association. The Belfield soils have characteristics intermediate between those of the Farland and Rhoades soils.

The soils of this association are susceptible to wind erosion, and the salty subsoil of some of them is a limitation to growing crops. Cash-grain farming is the main farm enterprise.

Shallow, Steep or Strongly Sloping Soils of the Uplands

In this group are two associations consisting of shallow, steep or strongly sloping soils of the uplands. These associations are described in the following paragraphs.

8. *Bainville-Midway association*

Shallow, excessively drained, loamy or clayey soils

This association occurs as rough land, or breaks, mainly along the Heart and Green Rivers. One of these rough areas, the Little Badlands, is southwest of Dickinson. Smaller areas are scattered throughout the county. The soils are rolling to steep and are mainly excessively drained. They formed in material weathered from shale that has a texture of loam, clay loam, or silty clay. The association occupies about 15 percent of the county.

The Bainville soils have a surface layer of grayish-brown loam, 2 to 5 inches thick. Immediately beneath the surface layer is partly weathered loamy shale. The Midway soils are similar to the Bainville, but they are underlain by clayey shale. Moreau, Morton, and Flasher soils occupy 10 to 30 percent of the association.

The soils of this association are susceptible to water erosion. Most of the association is in range, but the steep slopes make good range management necessary.

9. *Bainville-Flasher association*

Shallow, excessively drained, loamy or moderately sandy soils

In this association are excessively drained soils that are shallow over shale and sandstone. The soils are sloping to steep; the slopes range from 9 to 50 percent. The association occupies about 4 percent of the county. The largest area is in the northeastern part.

The Bainville soils have a surface layer of grayish-brown loam 2 to 5 inches thick. Immediately beneath the surface layer is partly weathered loam or silt loam shale.

The Flasher soils have a surface layer of dark grayish-brown fine sandy loam 2 to 9 inches thick. In most places the surface layer is underlain by soft, weathered sandstone, but these soils have a thin, weakly defined subsoil in a few places.

Areas of Vebar soils occur within this association in some places. The Vebar soils are deep and moderately sandy.

The soils of this association are not suitable for cultivation. Their primary use is for grazing.

Descriptions of the Soils

This section is provided for those who want information about the soils in the county. It describes the single soils, or mapping units; that is, the areas on the detailed soil map that are bounded by lines and are identified by a symbol. For more general information about the soils, or mapping units, that is, the areas on the detailed Map," in which the broad patterns of soils in the county are described. The acreage and proportionate extent of each soil mapped in the county are given in table 1. Their location is shown on the soil map at the back of the report.

In the descriptions that follow, the soils in a series are first discussed as a group by describing important features that apply to all the soils in the series. The location of the soils in the county is generally given, as well as the position of the soils on the landscape. Some of the nearby or similar soils are named and compared with the soils in the series being described. After the general description of the series is a broad statement that tells how the soils are used.

Following the description of each series are descriptions of each soil in the series. Generally, these descriptions tell how the profile of the soil described differs from the one described as representative of the series. They also tell about the use and suitability of the soil described and something about its management needs.

Detailed, layer-by-layer descriptions of soil profiles are not given in this section. A detailed description of

TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Mapping unit	Acres	Percent	Mapping unit	Acres	Percent
Arnegard loam, level	14, 192	1. 7	Moreau silty clay, level	8, 862	1. 0
Arnegard loam, gently sloping	5, 202	. 6	Moreau silty clay, gently sloping	45, 652	5. 4
Bainville and Midway soils, undulating	489	(1)	Moreau silty clay, sloping	9, 581	1. 1
Bainville and Midway soils, steep	63, 934	7. 6	Moreau stony soils	282	(1)
Bainville and Midway stony soils	414	(1)	Moreau-Midway silty clays, strongly sloping	448	(1)
Bainville-Rhoades complex, strongly sloping	692	(1)	Moreau-Rock outcrop complex	1, 631	. 2
Bainville-Shale outcrop complex	14, 621	1. 7	Moreau-Midway-Rock outcrop complex	1, 261	. 1
Banks and Glendive soils	398	(1)	Morton stony loam	992	. 1
Beckton complex	1, 949	. 2	Morton-Bainville complex, strongly sloping	3, 331	. 4
Belfield-Rhoades loams, level	19, 344	2. 3	Morton-Chama clay loams, sloping	8, 552	1. 0
Belfield-Rhoades loams, gently sloping	10, 923	1. 3	Morton-Chama silt loams, sloping	20, 853	2. 5
Belfield-Rhoades silty clay loams, level	16, 760	2. 0	Morton-Chama silt loams, sloping, eroded	19, 672	2. 3
Belfield-Rhoades silty clay loams, gently sloping	8, 652	1. 0	Morton and Farland clay loams, level	2, 475	. 3
Chama-Bainville loams, sloping	9, 617	1. 1	Morton and Farland clay loams, gently sloping	14, 277	1. 7
Chama-Bainville loams, strongly sloping	30, 527	3. 6	Morton and Farland silt loams, level	19, 284	2. 3
Cherry silty clay loam, gently sloping	585	(1)	Morton and Farland silt loams, gently sloping	79, 077	9. 4
Cherry silty clay loam, sloping	1, 413	. 2	Morton-Rhoades loams, level	917	. 1
Colvin silt loam	157	(1)	Morton-Rhoades loams, gently sloping	9, 551	1. 1
Dimmick clay	525	(1)	Morton-Rhoades loams, sloping	4, 620	. 5
Eroded sandy land	876	. 1	Morton-Rhoades loams, sloping, eroded	1, 110	. 1
Farland silt loam, gently sloping	2, 325	. 3	Parshall fine sandy loam, level	10, 221	1. 2
Farland silt loam, sloping	471	(1)	Promise silty clay, level	5, 659	. 7
Farland, Arnegard and Grail silt loams, level	18, 605	2. 2	Promise silty clay, gently sloping	7, 937	. 9
Flasher sandy loam, sloping	2, 707	. 3	Regent silty clay loam, level	4, 207	. 5
Flasher complex	26, 738	3. 2	Regent silty clay loam, gently sloping	15, 373	1. 8
Flasher-Rock outcrop complex	4, 720	. 6	Regent-Moreau silty clay loams, level	4, 239	. 5
Gallatin clay loam	397	(1)	Regent-Moreau silty clay loams, gently sloping	20, 859	2. 5
Glendive fine sandy loam	2, 751	. 3	Regent-Moreau silty clay loams, sloping	7, 906	. 9
Grail silty clay loam, level	19, 391	2. 3	Rhoades and Belfield soils, level	43, 308	5. 1
Grail silty clay loam, gently sloping	7, 773	. 9	Rhoades and Belfield soils, gently sloping	15, 334	1. 8
Grail silty clay loam, sloping	917	. 1	Saline alluvial land	2, 895	. 3
Grail soils, saline	1, 312	. 2	Savage silty clay loam	6, 664	. 8
Grail-Rhoades silty clay loams, level	725	(1)	Savage-Rhoades silty clay loams, level	1, 155	. 1
Grail-Rhoades silty clay loams, gently sloping	750	(1)	Searing loam	284	(1)
Gravelly land	3, 738	. 4	Shale outcrop-Bainville complex	1, 101	. 1
Havre loam	4, 587	. 5	Shale outcrop	1, 613	. 2
Havre silty clay loam	1, 051	. 1	Straw loam, level	6, 057	. 7
Hoven soils	1, 531	. 2	Straw and Havre soils, channeled	18, 265	2. 2
Lefor fine sandy loam, undulating	5, 236	. 6	Valentine fine sand, hilly	183	(1)
Lefor fine sandy loam, undulating, eroded	3, 410	. 4	Vebar-Flasher fine sandy loams, strongly sloping	9, 917	1. 2
Lefor fine sandy loam, sloping	1, 309	. 2	Vebar-Manning fine sandy loams, sloping	250	(1)
Lefor fine sandy loam, sloping, eroded	3, 753	. 4	Vebar-Parshall fine sandy loams, undulating	41, 803	5. 0
Lihen loamy fine sand, undulating	2, 527	. 3	Vebar-Parshall fine sandy loams, sloping	29, 575	3. 5
Lihen-Flasher loamy fine sands, rolling	3, 268	. 4	Wet alluvial land	439	(1)
Little Horn and Duncom soils, level	412	(1)	Wibaux soils	911	. 1
Little Horn and Duncom soils, gently sloping	261	(1)	Areas in the city of Dickinson that were not mapped	400	(1)
Manning loam, level	2, 675	. 3	Gravel pits	135	(1)
Manning fine sandy loam, level	4, 448	. 5	Water	2, 016	. 2
Manning fine sandy loam, gently sloping	2, 937	. 3			
Manning fine sandy loam, sloping	801	(1)			
Mine dumps	230	(1)	Total	844, 160	100. 0

[1] Less than 0.1 percent.

a representative profile for each series is described in the section "Genesis, Classification, and Morphology of Soils." Some of the terms used in the soil descriptions are defined in the section "How This Survey Was Made." Other terms are described in the Glossary at the back of this report.

Arnegard Series

The Arnegard series consists of deep loams and silt loams that are nearly level or gently sloping. These soils are in swales and in intermittent drainageways in the uplands. They have developed in loamy material washed from the adjacent slopes.

The surface layer is very dark grayish-brown or black, friable loam or silt loam about 10 inches thick. It has crumb structure and is free of lime.

The subsoil is generally dark grayish-brown loam or light clay loam that is about 30 inches thick and has distinct prismatic and blocky structure. In many areas, however, part of the subsoil is as dark as the surface layer. This dark color indicates that the subsoil contains the surface layer of an old soil that has been buried by later deposits. The subsoil does not contain lime.

The substratum ranges from fine sandy loam to silt loam in texture. It has blocky structure or is structureless (single grain) and is easily penetrated by roots and water. The lower part of the substratum is calcareous in

most places, but it is free of salts that restrict the growth of plants.

The thickness of the surface layer ranges from 7 to 18 inches. The subsoil ranges from very dark grayish brown to dark brown in color and from 28 to 40 inches in thickness. The texture of the substratum varies from place to place; the substratum is more sandy in the areas where the Arnegard soils occur with the Vebar, Parshall, and Flasher soils than where they occur with the Morton soils.

The Arnegard soils are easily worked. They are well drained and take in water readily. They receive extra moisture in runoff from the adjacent slopes, and they hold more water available for plants than do most of the soils of the county. The Arnegard soils have high natural fertility and are considered the most productive soils in the county. Wind erosion is a slight hazard. Water erosion occurs only in scattered areas.

These soils have a surface layer and a subsoil that are darker and thicker than those of the Morton and Farland soils. They are darker, but less sandy, than the Vebar and Parshall soils. The Arnegard soils, like the Grail, occur in swales and drainageways, but their subsoil and substratum contain less clay than do the corresponding layers in the Grail soils.

The Arnegard soils are suitable for field crops, trees, and grasses commonly grown in this area. Most of the acreage is cultivated.

Arnegard loam, level (0 to 3 percent slopes) (ArA).—This soil is in long, narrow areas in nearly level drainageways and swales in the uplands. It receives extra moisture as runoff from the adjacent slopes.

The surface layer is very dark grayish-brown or black, very friable, noncalcareous loam or silt loam about 10 inches thick. The subsoil is friable loam about 32 inches thick. Below the subsoil, the soil material contains a small amount of lime.

This soil occurs with the Vebar-Parshall fine sandy loams, the Morton and Farland silt loams, and the Grail silty clay loams. Small areas of these associated soils make up 5 to 15 percent of the acreage of this mapping unit.

This is the most productive soil in the county, and it is easily managed. It is only slightly eroded in places, although most of the acreage is cultivated. Corn and all the commonly grown small grains make favorable yields. Wind erosion is a slight hazard, but it can be controlled by leaving part of the crop residue on the surface each year. This soil is well suited to trees grown for windbreaks. (Capability unit IIc-6, Silty range site)

Arnegard loam, gently sloping (3 to 6 percent slopes) (ArB).—This soil is in concave, gently sloping swales, in drainageways, and on foot slopes adjacent to steeper soils of the uplands. The slopes are shorter than those on which Arnegard loam, level, occurs, and this soil is more susceptible to water erosion than Arnegard loam, level (fig. 3). Eroded spots and small rills occur in many cultivated fields.

This soil occurs with the Vebar-Parshall fine sandy loams, Morton and Farland silt loams, and Grail silty clay loams. Areas of these associated soils are mapped with this soil and make up as much as 15 percent of the mapping unit. This soil is excellent for trees. (Capability unit IIIe-6, Silty range site)

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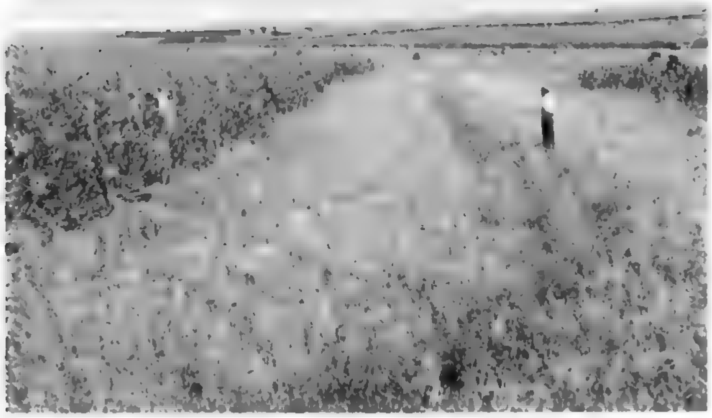

***Figure 3.*—A grassed waterway used to control water erosion and to prevent the formation of gullies in a field of Arnegard loam, gently sloping. The grasses are bromegrass and western wheatgrass.**

Bainville Series

In the Bainville series are sloping to steep, medium-textured soils that are shallow over loamy, soft shale. These soils are on the uplands, and they developed in material weathered from shale (fig. 4).

The surface layer is very dark grayish-brown or dark grayish-brown, friable loam about 4 inches thick. It has crumb and fine blocky structure and contains free lime.

Just beneath the surface layer is olive-colored, loamy, partly weathered shale that has platy structure or is massive. This material, the substratum, consists of several layers that differ in color or texture. It contains many small pockets of white lime.

The thickness of the surface layer ranges from 2 to 5 inches, and the texture of that layer ranges from very fine sandy loam to light clay loam. The color of the substratum ranges from pale olive to dark gray. The range in texture of the substratum is the same as that of the surface layer. In many places the substratum is mottled with brown and reddish brown and contains black iron and manganese concretions.

These soils are excessively drained and are low in natural fertility. Moisture from rain and snow rarely penetrates them to a depth greater than 20 inches. They are highly susceptible to wind and water erosion. Permeability is moderate in the surface layer and slow in the substratum.

The Bainville soils in Stark County generally occur with the Midway soils. Although they are on similar slopes and are in the same general areas, the Bainville soils developed on loamy shale and the Midway soils on clayey shale. In most parts of the county, the Bainville soils are on the steeper upper part of the slopes, and the Chama, Regent, and Morton soils are below them on the lower part of long slopes. Unlike the Regent and Morton soils, the Bainville soils have a calcareous surface layer and lack a definite subsoil. The Bainville soils are shallow like the Flasher soils, but they are underlain by loamy shale instead of sandstone.

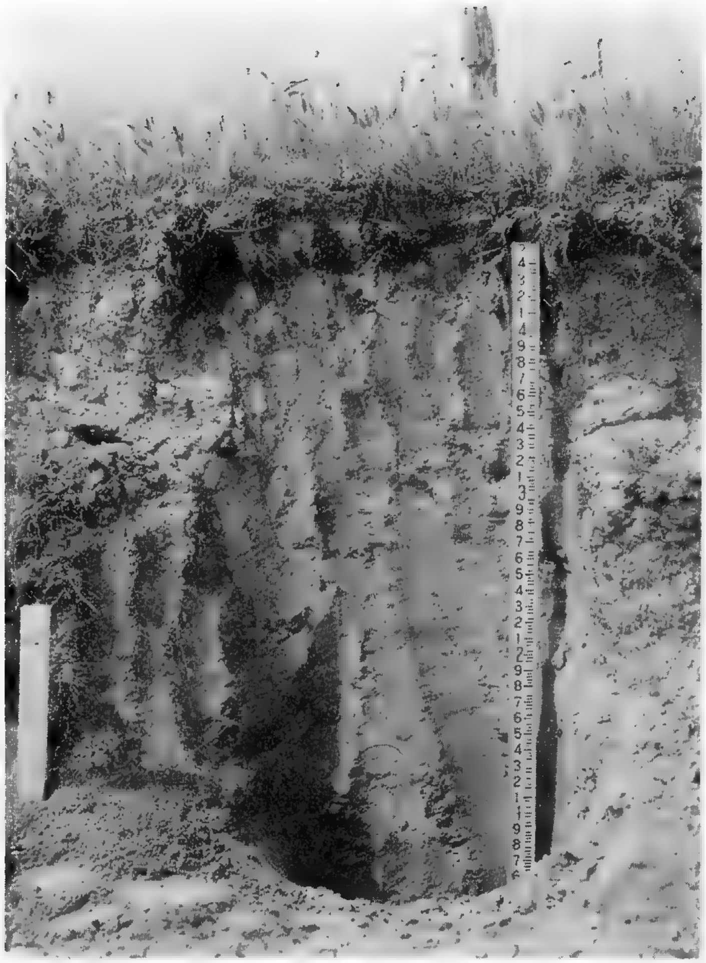

Figure 4.—**A profile of Bainville loam. The dark-colored surface layer is just above the light-colored shaly substratum.**

The Bainville soils are not suitable for cultivated crops or trees. Most of the areas are used as range.

Bainville and Midway soils, undulating (3 to 6 percent slopes) (BaB).—In this mapping unit are shallow soils on knolls and ridgetops in the uplands (fig. 5). Bainville soils make up 40 to 60 percent of the unit; Midway silty clay makes up 30 to 40 percent; and Moreau, Morton, and Regent soils make up 15 to 20 percent. The soils occur in small areas (3 to 10 acres in size) mainly in cultivated fields. Their total acreage is small, and the areas are widely scattered throughout the county.

These soils have lost most of their original surface layer through erosion by wind and water. Part of the light-colored substratum is mixed with the present surface layer each time the soils are plowed. The texture of the present surface layer ranges from silt loam to silty clay.

These soils are low in fertility and are in poor tilth. Where it is practical, they should be seeded to perennial grasses and used for hay, fall grazing, or wildlife areas. These soils are not suitable for trees. (Capability unit VIe–TSi, Thin Silty range site)

Bainville and Midway soils, steep (9 to 40 percent slopes) (BaD).—The soils of this mapping unit are on escarpments along river valleys and on the side slopes of buttes in the uplands. They are the steepest soils in the county. Bainville soils make up 30 to 40 percent of the acreage; Midway soils make up another 30 to 40 percent; and Moreau silty clay, Regent silty clay loam, and Cherry silty clay loam, all on the lower part of the slopes, make up 15 to 30 percent. The Bainville and Midway soils are shallow over silty and clayey shale.

The soils of this mapping unit take in water slowly. Surface runoff is rapid.

These soils are mainly in range, but spots where there is little or no grass occupy 5 to 15 percent of each area. These spots differ from the soils of this mapping unit in that a soil profile has not developed. The soils of this mapping unit are highly susceptible to water erosion. Water erosion is severe if the soils are overgrazed or the cover of grass is destroyed. The range can be protected by controlling the length of time for grazing, distributing livestock over the range, and allowing grazing only in seasons when the grass can be grazed without injury. These soils are not suitable for trees. (Capability unit VIe–TSi, Thin Silty range site)

Bainville and Midway stony soils (15 to 35 percent slopes) (Bd).—The soils of this mapping unit are along the sides of small buttes, mainly in only two or three townships in the extreme southwestern part of the county. Siliceous stones, or pieces of flint, about 10 to 24 inches in diameter cover about 10 percent of the surface. About 50 percent of the acreage is Bainville loam, about 35 percent is Midway clay loam, and about 15 percent is Moreau silty clay. The profiles of the Bainville and Midway soils are like those described for the Bainville and Midway series, except for the stones on and in the surface layer.

The soils of this unit are best suited to native grass for summer and fall grazing. They are not suitable for trees. (Capability unit VIe–TSi, Thin Silty range site)

Bainville-Rhoades complex, strongly sloping (9 to 15 percent slopes) (BeD).—The soils of this complex occur in a spotty pattern of shallow Bainville soils that lack a pan layer and of shallow Rhoades soils that contain a pan layer. They are on uplands in areas of low hills and escarpments. The length of the slopes in these areas

Figure 5.—**An area of Bainville and Midway soils, undulating, at the edge of a cultivated field. Morton soils are on the slopes in the background, and Grail soils are in the drainageways.**

ranges from 100 to 250 feet. The Bainville soils are mainly on the upper part of the slopes, and Rhoades and Belfield soils are on the lower part. Small pits or depressions, mainly occupied by Rhoades soils, give the surface a pock-marked appearance. The pits have only a sparse cover of grass and are locally called gumbo or scab spots. The cover of native grass on the areas other than the pits ranges from sparse to moderately thick.

The soils of this unit are used for summer and fall grazing. The range can be kept in good to excellent condition by grazing the pastures so that about half of the annual growth of grass remains. Contour pitting or furrowing can be used on the lower part of the slopes to increase the intake of water. These soils are not suitable for trees. (Capability unit VIs–Ps, Panspot range site)

Bainville-Shale outcrop complex (15 to 35 percent slopes) (Bf).—The soils of this complex are on steep escarpments and on valley breaks. They are mainly in the area known as the Little Badlands and along the edges of the valleys of the Heart, Green, and Knife Rivers. About 30 to 35 percent of the complex is Bainville loam, 30 to 35 percent is Midway clay loam, and 15 to 35 percent is bare areas. The bare areas are mainly shale outcrops, and the lack of vegetation in those areas permits continual erosion.

The soils of this complex have a sparse to moderately thick cover of native grass and are used mainly for summer range. The yield of forage is about half that on deep sloping soils. If the grass is overgrazed, these soils are highly susceptible to water erosion. They are not suitable for trees. (Capability unit VIIs–TB, Thin Breaks range site)

Banks Series

In the Banks series are deep, nearly level to gently undulating, sandy soils developed in recent alluvium. These soils are on the lower flood plains of the Heart River.

The surface layer is dark grayish-brown, loose loamy sand about 4 inches thick. It is single grained or has weak blocky structure.

Below the surface layer are several thin layers of sandy loam, loamy sand, and sand. Each layer consists of a different alluvial deposit left when this area was flooded. The soil material in these layers is noncalcareous in most places and is single grained.

The color of the surface layer ranges from grayish brown to dark grayish brown, and the thickness ranges from 3 to 12 inches. In many areas the layers in the lower part of the profile are as dark as the surface layer because they are the surface layer of an old, buried soil of the flood plain.

These soils have good surface drainage and rapid internal drainage. They are droughty for shallow-rooted plants, but trees and deep-rooted legumes grow well because of the temporary water table at a depth of 4 to 8 feet. Every 2 to 3 years, these soils are subject to stream overflow. They are low in fertility and are highly susceptible to wind erosion if the native stands of trees and grasses are removed.

The Banks soils occur with the Havre and Glendive soils. They are somewhat similar to those soils and differ mainly in texture. The Banks soils consist of several layers of loamy sand and sand, the Havre soils have a texture of loam to silty clay loam, and the Glendive soils have a texture of sandy loam and fine sandy loam.

Banks and Glendive soils (2 to 6 percent slopes) (Bg).—This mapping unit consists of moderately sandy and sandy soils between the meanders of the Heart River channel. The areas are subject to stream cutting and to deposition of sediments. About 60 percent of the acreage is Banks loamy sand, and 40 percent is Glendive fine sandy loam. The profiles of these soils are like the profiles described for the Banks and Glendive series. These soils are subject to water erosion during periods of spring runoff and during heavy rains. When the river is at flood stage, some of the areas receive deposits of sandy sediment, and other areas are eroded. Wind erosion is also a serious hazard if the cover of plants is removed.

Nearly all areas of these soils in Stark County support a mixed stand of native grasses and trees, which protect them from erosion. The soils are better suited to grazing or wildlife habitats than to other agricultural uses. Loss of the permanent cover of plants would create an extreme hazard of wind erosion between periods of flooding. These soils are good for trees. (Capability unit VIe–Sa, Sands range site)

Beckton Series

The Beckton series consists of moderately deep, nearly level or undulating soils that contain a claypan. These soils developed in material weathered from clayey, alkaline shale that has a thin deposit of moderately sandy windblown material on the surface. They are in small, scattered areas in the uplands.

The surface layer is about 10 inches thick. The upper part is very dark grayish-brown, friable fine sandy loam that has fine blocky structure. It is noncalcareous and is easily worked. The lower part is grayish-brown, loose, single grained fine sandy loam.

An abrupt boundary separates the surface layer and the subsoil. The subsoil consists of dense, clayey material that restricts the penetration of roots. It has coarse columnar structure and is about 10 inches thick. The upper part is noncalcareous, but the lower part contains a concentration of soluble alkali salts and lime. The hardness and density of the subsoil have been caused partly by the presence of sodium salts.

The substratum contains numerous salt pockets and consists of dense, clayey material weathered from shale. It has platy structure or is massive.

The surface layer ranges from 6 to 18 inches in thickness, and the texture in some places is sandy loam instead of fine sandy loam. The texture of the subsoil ranges from sandy clay loam to sandy clay or silty clay, and the structure ranges from medium to very coarse columnar. The lower part of the subsoil is moderately to strongly saline, and it is slightly calcareous to noncalcareous. The thickness of the subsoil ranges from 8 to 20 inches.

These soils have good surface drainage but slow internal drainage. They are highly susceptible to wind erosion. In a few places the moderately sandy windblown deposits are so thick that both the surface layer and subsoil have a texture of sandy loam. In these minor areas are soils that resemble the Ekalaka soils that occur

in adjacent counties. The Beckton soils have a thicker, coarser textured surface layer than the Rhoades soils. They have a coarser textured surface layer than the Belfield soils, and the structure of their subsoil is coarse columnar instead of prismatic and blocky.

About half of the acreage of Beckton soils is used for growing small grains. The other half is in tame and native pastures.

Beckton complex (2 to 8 percent slopes) (Bk).—In this complex are the only Beckton soils mapped in Stark County. About 60 to 70 percent of the complex is Beckton fine sandy loam, 15 to 30 percent is Rhoades soils, and 5 to 15 percent is Lihen soils. The Beckton and Rhoades soils do not occur in a well-defined pattern. The Beckton soils, however, are generally on ridge crests and on the upper part of the slopes where the deposits of sandy material are the thickest. The soils are in undulating areas where the slopes are short. The ridges extend from northwest to southeast, indicating that the strong prevailing winds blew from the northwest at the time the uppermost layer of soil material was laid down.

Where these soils have been cultivated, they have lost from 25 to 75 percent of their surface layer through wind erosion. In some areas there are scabby spots and slickspots where all the surface layer has been removed. Small blowout spots occur in places, and drifted soil material has accumulated along fence lines in some areas.

The soils of this complex are difficult to manage because they are droughty, salty, and susceptible to wind erosion if they are cultivated. Wind stripcropping and stubble-mulch summer fallow are effective management practices for controlling wind erosion. These soils are better suited to wheat and barley than to other field crops. Where they are used for pastures of native and tame grasses, good yields of forage are obtained. These soils are not suitable for trees. (Capability unit IIIe-3P, Sandy range site)

Belfield Series

In this series are deep, dark-colored, nearly level to gently sloping soils on uplands and stream terraces. These soils have developed in loam and clay loam shale and in alluvium.

The surface layer is very dark grayish-brown loam, silt loam, or silty clay loam that has crumb or fine blocky structure and is about 8 inches thick. It is free of lime and is easily worked. The lower part of the surface layer is lighter colored than the upper part.

The subsoil is grayish-brown or dark grayish-brown clay loam to silty clay about 20 inches thick. It contains a greater amount of clay than the surface layer. The subsoil is free of lime and has distinct prismatic and blocky structure. The prisms and blocks are covered by a dark-colored coating.

The substratum has weak blocky structure or is structureless. It consists of grayish-brown and light olive-brown, unweathered silty shale, clay loam shale, and terrace sediments. Lime and salts are concentrated in the upper part.

The thickness of the surface layer ranges from 6 to 11 inches. The thickness of the subsoil ranges from 12 to 24 inches.

These soils are well drained, but water moves slowly through the subsoil and substratum. Natural fertility is moderately high, but these soils are slightly susceptible to wind and water erosion.

The Belfield soils have a thicker surface layer and subsoil than the Rhoades soils and are less salty than those soils. They have a thin, grayish layer between the surface layer and the subsoil that is absent in the Morton, Farland, and Regent soils, and they also have a salty substratum.

About half of the acreage of Belfield soils is cultivated, and the most commonly grown crop is spring wheat. The rest of the acreage is used for range or for growing tame grasses for hay.

Belfield-Rhoades loams, level (0 to 3 percent slopes) (BoA).—This complex consists mainly of deep, loamy Belfield soils intermixed with shallow claypan Rhoades soils. Belfield loam makes up 50 to 65 percent of the complex, Rhoades loam makes up 20 to 35 percent, and Morton and Farland silt loams make up 10 to 15 percent. These soils occur in such an intricate pattern that it was not practical to separate them on the map. They occur with the undifferentiated units of Rhoades and Belfield soils.

The Belfield soils have a thick surface layer of loam or silt loam and a subsoil of friable clay loam. They contain limy and salty layers below a depth of 30 inches. The Rhoades soils have a surface layer that is less than 6 inches thick, a dense claypan subsoil, and a salty substratum within 20 inches of the surface. They make up the scabby or slickspot areas that occur both in areas of range and in cultivated fields. Where the soils of this complex are in native prairie, there are some areas of microrelief consisting of small depressions, 3 to 12 inches deep, surrounded by slightly higher areas. The vegetation is sparse in the depressions, but a thick stand of grass covers the slightly higher areas.

Where these soils occur in a cultivated field, part of the surface layer has a grayish, crusted appearance. In those areas the upper part of the dense subsoil has been mixed into the plow layer by tillage.

The soils of this complex are fair for field crops and good for range. In the areas where Rhoades soils occur, crop yields are reduced as a result of the poor soil structure and the content of salts. The soils are better suited to adapted varieties of wheat, barley, and oats than to other crops. They are not suitable for trees. (Capability unit IIIs-5P, Silty range site).

Belfield-Rhoades loams, gently sloping (3 to 6 percent slopes) (BoB).—The soils of this complex are in the uplands on long single slopes that are dissected by intermittent drainageways. The complex consists mainly of deep Belfield loam and of Belfield silt loam, mixed with shallow claypan Rhoades soils. Its approximate composition is 50 to 65 percent Belfield loam, 20 to 35 percent Rhoades loam, and 5 to 20 percent Morton silt loam and Grail silty clay loam. In many places the soils occur with the soils of the Rhoades and Belfield undifferentiated units and with the soils of the Morton-Rhoades complexes. In many of the areas that have been cultivated, water erosion has removed from 25 to 75 percent of the surface layer.

The poor soil structure and salts in the subsoil make management difficult in the scabby areas of Rhoades

soils. Tilling across the slope increases the intake of water and helps to overcome the difficulties caused by the poor soil structure and salty subsoil. Additions of nitrogen and phosphate fertilizer generally increase yields. These soils are not suitable for trees. (Capability unit IIIe–6P, Silty range site)

Belfield-Rhoades silty clay loams, level (0 to 3 percent slopes) (BrA).—This soil complex consists mainly of areas of deep Belfield silty clay loam, mixed in an irregular pattern with areas of shallow Rhoades soils. The Belfield soil generally occupies the large areas between scabby spots or patches occupied by the Rhoades soils. The estimated composition of the complex is 50 to 60 percent Belfield silty clay loam and 35 to 45 percent Rhoades loam or Rhoades clay loam. In many places 5 to 10 percent of the acreage consists of Savage and Regent silty clay loams.

The soils of this complex are on nearly level terraces along the main branches of the Heart River and south branch of the Knife River. They are also on nearly level uplands, primarily in the western one-third of the county. In the same general area are the silty clay loams of the Regent-Moreau soil complexes and of the Rhoades and Belfield undifferentiated units.

The Belfield soil of this complex has a profile similar to the one described for the Belfield series. It has a dark-colored surface layer, more than 6 inches thick, and a subsoil of friable clay loam or silty clay that has good soil structure. The profile of the Rhoades soils is similar to the one described for the Rhoades series. The Rhoades soils have a thin surface layer of loam or clay loam and a dense claypan subsoil that has salts in the lower part.

The soils of this complex are fair to good for crops if they are properly managed. Yields are lower on the Rhoades than on the Belfield soil, because of the content of salts and the poor soil structure in the subsoil. The effects of these limitations are more pronounced in years of below-normal rainfall than when rainfall is normal or above normal. Wind erosion is a serious hazard, unless suitable practices that control erosion are used.

A small grain may be grown every other year on these soils, and the soils should be left fallow during the alternate summer. The small grain needs to be fertilized according to the results of soil tests. While the soils are fallow, a straw mulch ought to be kept on or near the surface. Farming across the slope or on the contour greatly reduces the amount of moisture lost through runoff and protects these soils from erosion. These soils are not suitable for trees. (Capability unit IIIs-5P, Clayey range site)

Belfield-Rhoades silty clay loams, gently sloping (3 to 6 percent slopes) (BrB).—The soils of this complex occur with the level phase of Belfield-Rhoades silty clay loams. Deep Belfield silty clay loam makes up 45 to 60 percent of the complex, and shallow Rhoades soils occupy 25 to 45 percent. In many areas an additional 5 to 15 percent of the acreage is made up of Morton clay loam and Moreau silty clay. The profiles of these Belfield and Rhoades soils are similar to the ones described for the Belfield and Rhoades series. The Belfield soil has a dark-colored surface layer that is more than 6 inches thick. The Rhoades soils have a thin surface layer.

Microdepressions occupied by Rhoades soils are prominent in many areas of this complex that are in native prairie. These have a sparse cover of plants. After several years of cultivation, these microdepressions disappear, but the Rhoades soils in the areas can still be recognized because of the crusted appearance and grayish-brown color of their surface layer.

Water erosion has removed from 25 to 75 percent of the surface layer in about two-thirds of the acreage that has been cultivated. Rills and small gullies have formed during periods of rapid runoff. These soils take in water slowly.

The soils of this complex are only fair for crops because of their salty subsoil or underlying material and the slow rate at which they take in water. Adapted small grains should be grown, adequate fertilizer ought to be applied, and runoff needs to be reduced by managing crop residue carefully. Where practical, farming ought to be done across the slope, either in contour strips or in field strips. These soils are not suitable for trees. (Capability unit IIIe–6P, Clayey range site)

Chama Series

Deep, medium-textured soils that have weakly defined horizons make up the Chama series. These soils are sloping and strongly sloping and are in the uplands. They developed in material weathered from limy silty shale.

The surface layer is very dark gray, very friable loam about 5 inches thick. Its structure is crumb or fine blocky. This layer contains a small amount of lime and is easily worked.

The subsoil is grayish-brown to dark grayish-brown, very friable loam or silt loam about 5 inches thick. It has weak, coarse, prismatic and medium blocky structure, and it contains a large amount of free lime.

The underlying material is normally unweathered silt loam or loam shale, but the texture is clay loam or silty clay loam in some places. This material has platy structure or is weakly bedded, but roots can penetrate it easily because it is soft. It has free lime throughout, but the lime is concentrated in nodules and threads in the upper part of the layer.

The surface layer ranges from 3 to 7 inches in thickness, and the texture is very fine sandy loam in some places. The subsoil ranges from 3 to 12 inches in thickness and is weakly calcareous to strongly calcareous. The color of the underlying material ranges from pale olive to pale yellow.

The Chama soils occur with the Morton and Bainville soils, and they are mapped in complexes with those soils. In many places all of these soils are on the same slope, with the Bainville soils on the upper and steeper parts of the slope, the Chama soils farther down, and the Morton soils on the lower part. The Chama soils developed in the same kind of material as the Morton soils, but they have a thinner subsoil than those soils and weaker soil structure. The Chama soils have a distinct subsoil that is lacking in the Bainville soils.

In Stark County about a third of the acreage of Chama soils is cultivated. The cultivated areas occur as minor parts of fields that consist mainly of Morton silt loams. The rest of the acreage is strongly sloping and is used as range.

Chama-Bainville loams, sloping (4 to 9 percent slopes) (CbC).—The soils of this complex occur as scattered areas

on the tops of small ridges and hills, mainly in cultivated fields. About 45 percent of the acreage is Chama loam, 35 percent is Bainville loam or Bainville silt loam, and 20 percent is Morton silt loam.

Erosion by wind and water has removed from 25 to 75 percent of the surface layer of these soils. Part of the subsoil or of the underlying material is mixed with the material in the surface layer each time the soils are tilled. The present surface layer is lighter colored than that of the less sloping Morton soils with which these soils occur. It has a texture of loam or silt loam and contains free lime. The underlying material has a slightly lighter color than the surface layer and has a texture of loam or clay loam.

These soils are low in available nitrogen and phosphorus. If they are used for cultivated crops, they require a fertilizer that contains these two plant nutrients. Their structure and moisture-storing capacity can be improved by including grass about half the time in the cropping system. Farming practices that help reduce runoff on these soils also increase the amount of moisture stored and reduce the hazard of further water erosion. These soils are fair for trees. (Capability unit IVe-4L, Silty range site)

Chama-Bainville loams, strongly sloping (9 to 15 percent slopes) (CbD).—This soil complex is mainly in the uplands and is used mostly for range. A smaller acreage is on scattered ridges and on the crests of hills in cultivated fields. About 50 percent of the acreage is Chama loam or Chama silt loam, about 35 percent is Bainville loam or Bainville silt loam, and 10 to 15 percent is Morton silt loam.

The Chama soil has a surface layer of dark-gray loam or silt loam about 4 to 6 inches thick and a subsoil of loam or silt loam about 11 inches thick. The Bainville soil has a surface layer that is similar to that of the Chama soil, but it lacks a definite subsoil. Lime is at the surface or within 2 inches of the surface. Underlying both soils is pale-olive, silty material weathered from shale.

Where these soils have been cultivated, they have been subjected to erosion by wind and water. Most of the surface layer has been lost, and erosion has removed part of the subsoil in some places. As a result, part of the underlying material is mixed with the remaining surface soil and subsoil when these soils are tilled.

These soils are suitable for both native and tame grasses. Only the lower part of the slopes is suitable for cultivated crops. These soils are not suitable for trees. (Capability unit VIe-TSi, Thin Silty range site.)

Cherry Series

In the Cherry series are deep, light-colored silty clay loams, developed in sediments eroded from the adjacent steep hilly areas. These soils are gently sloping and are on foot slopes along the margins of the valley of the Heart River.

In a typical profile of these soils, the surface layer is dark grayish-brown, friable silty clay loam. It has crumb or fine blocky structure, is about 3 inches thick, and is easily worked.

The subsoil has the same color as the surface layer, but it contains more clay than the surface layer. The subsoil is calcareous. It has coarse prismatic and medium angular blocky structure and is about 28 inches thick. The subsoil contains small threads and patches of lime.

Beneath the subsoil is olive-gray light silty clay or silty clay loam that grades to slightly weathered material. This material has medium blocky structure or is massive.

In some places the surface layer is slightly calcareous. Its thickness ranges from 2 to 5 inches. The texture of the subsoil is silty clay loam and silty clay. The thickness of the subsoil ranges from 25 to 33 inches, but the areas where it is thickest are on the lower part of the slopes. The underlying material ranges from olive to olive gray in color, and its texture is silty clay loam and silty clay. Small pieces of black lignite and red scoria are common throughout the profile.

These soils are well drained. The upper part of their profile is moderately permeable, and the lower part is slowly permeable. Water erosion is a hazard.

The Cherry soils occur with the Grail, Farland, Savage, Morton, and Bainville soils. They are lighter colored and have less distinct layers than the Grail, Farland, Savage, and Morton soils, and they have lime higher in their profile. They have thicker layers and better developed soil structure than the Bainville soils.

The Cherry soils are good for crops. Most of the areas are cultivated and are used mainly for growing small grains.

Cherry silty clay loam, gently sloping (2 to 6 percent slopes) (ChB).—This soil occupies a minor acreage along the Heart River and Antelope Creek. It is in long, narrow bands, between flat bottom lands and terraces and the steep river breaks. About 90 percent of the acreage is Cherry silty clay loam. About 10 percent consists of Bainville and Midway soils.

The surface layer is noncalcareous silty clay loam about 4 inches thick. The subsoil is calcareous silty clay loam or silty clay about 28 inches thick. In most places part of the subsoil has been mixed into the surface layer by tillage. As a result, the present surface layer is calcareous in many places.

This soil is easily worked, but a surface crust, caused by the low content of organic matter in the surface layer, forms readily after brief showers or rains. The soil is especially well suited to farming across the slope, and this practice helps to control water erosion and increases the supply of soil moisture. Water erosion, caused by the runoff from the adjacent breaks and steep slopes, causes the formation of rills and small gullies. Grassed waterways are needed in areas where the runoff water concentrates.

This soil is farmed with the soils of the bottom lands and most of it is cultivated. It is fair for trees. (Capability unit IIIe-4, Clayey range site)

Cherry silty clay loam, sloping (6 to 9 percent slopes) (ChC).—This soil is in long, narrow bands between flat bottom lands and the steep river breaks, along the edges of the valley of the Heart River. The slopes are mainly between 6 and 9 percent, but they are between 9 and 12 percent in a few places. About 80 percent of the acreage is Cherry silty clay loam, and about 20 percent is Bainville and Midway soils.

The surface layer is grayish-brown, friable silty clay loams about 4 inches thick. It has crumb or fine blocky structure. The subsoil is light silty clay or silty clay loam about 26 inches thick. It has weak prismatic and moderate blocky structure. Where this soil has been cultivated,

it has lime throughout the profile. The uppermost 3 inches is noncalcareous in areas that have not been cultivated.

In most of the cultivated areas, water erosion has removed from 25 to 50 percent of the original surface layer. In many places small gullies have formed where intermittent drainageways cross this soil. Grassed waterways are needed in those areas.

These are good soils for crops, and about two-thirds of the acreage is cultivated. The soils need protection from water erosion. Erosion can be kept to a minimum by leaving the stubble of small grains undisturbed between growing seasons and by establishing grassed waterways where intermittent drainageways cross these soils. This soil is fair for trees. (Capability unit IIIe-4, Clayey range site)

Colvin Series

In the Colvin series are deep, nearly level, poorly drained soils that have a high content of lime. These soils occur in only two or three small areas in the central part of the county. They are in broad, flat-bottomed drainageways that drain the adjacent sloping and rolling uplands. The areas are flooded only occasionally, but they have a permanent water table within 1 to 4 feet of the surface.

The surface layer is very dark brown or black, very friable silt loam that contains free lime and is about 12 inches thick. It has crumb structure in the upper part but prismatic and blocky structure in the lower part.

An abrupt boundary separates the surface layer from the subsoil. The subsoil is a thin transitional layer of very dark gray silty clay loam that has weak prismatic structure. The upward movement of water from the water table has concentrated lime in this layer. Abundant patches and streaks of white lime are easily seen.

The substratum is grayish-brown silt loam or silty clay loam that is massive. It contains a large amount of lime and has mottles of yellow, brown, or red in most places. The mottling is caused by a fluctuating high water table. In most places the substratum contains alkali salts.

The surface layer ranges from 8 to 18 inches in thickness, and it is calcareous. The texture of the subsoil ranges from silt loam to silty clay loam. In many places the Colvin soils do not have a clearly expressed subsoil and the surface layer rests directly on the substratum. The color of the mottles varies considerably, and depth to mottling ranges from 20 to 40 inches. The texture of the substratum ranges from sandy loam to silty clay loam.

These soils have a permanent water table within 1 to 4 feet of the surface. They are flooded only occasionally.

The Colvin soils occur with the Grail, Arnegard, and Farland soils, but they have a less distinct subsoil than those soils and they are less well drained. They are more friable throughout the profile than the Dimmick and Hoven soils, and they have a higher content of lime. The Colvin soils are less clayey than the Dimmick and Hoven soils and are poorly drained as the result of a high water table instead of surface ponding.

In Stark County the Colvin soils are used to grow native and tame grasses for hay and pasture. These soils are not well suited to cultivated crops, but they produce high yields of forage.

Colvin silt loam (0 to 3 percent slopes) (Co).—This is the only Colvin soil mapped in this county. It is in broad swales and drainageways in the uplands and is mainly nearly level. In many places, however, frost heaving has caused rough microrelief.

The surface layer of this soil is dark-colored, very friable silt loam that contains lime and is about 12 inches thick. In some places the subsoil is a thin layer of highly calcareous silty clay loam. Where the subsoil is absent, the surface layer rests on a substratum of structureless sandy loam to silty clay loam that contains lime.

This soil is poorly drained because of the high water table. Additional water is received from the adjacent sandy uplands, and drainage is not practicable. This soil is not suited to trees. (Capability unit Vw-Sb, Subirrigated range site)

Dimmick Series

In the Dimmick series are dark-colored, nearly level soils that are poorly drained. These soils are in shallow basins, both in the uplands and on stream terraces.

The surface layer is very dark brown silty clay loam that is free of lime and is about 4 inches thick. It has fine granular structure.

The subsoil is very dark grayish-brown, nonlimy silty clay about 19 inches thick. It is commonly mottled or streaked with brown and yellowish brown, and the mottles or streaks increase in number with increasing depth. The subsoil has very strong, medium, blocky structure.

Beneath the subsoil is slightly calcareous, structureless alluvium that has been washed in from the adjacent slopes. The alluvium has a texture of clay or silty clay and is mottled with a number of different colors, ranging from greenish gray to yellowish brown. It is usually saturated. Lime occurs at a depth of 30 to 60 inches.

The surface layer ranges from very dark brown to very dark gray in color, from silty clay loam to clay in texture, and from 3 to 8 inches in thickness. The subsoil ranges from dark gray to very dark grayish brown in color, from silty clay or clay to sandy clay in texture, and from 14 to 24 inches in thickness. In places the color of the mottles or streaks is yellow or green instead of brown or yellowish brown.

The Dimmick soils have slow internal drainage. They are more poorly drained than the Hoven soils, which are also in basins, and they have a more friable surface layer than those soils. They contain more clay, are less limy, and are more poorly drained than the Colvin soils.

In Stark County the Dimmick soils are used for hay and pasture, and they are also used for field crops. Good yields of small grains are obtained if surface drainage is installed. Where these soils have not been drained, they support a mixture of wetland sedges, rushes, and grasses.

Dimmick clay (0 to 1 percent slopes) (Dk).—This is the only Dimmick soil mapped in this county. It is nearly flat and is poorly drained. This soil is in basins scattered throughout the northern part of the county. It receives runoff that flows down the adjacent slopes and is impounded in the basin. This soil is usually flooded for 1 to 2 months during the growing season.

The surface layer is very dark brown, very friable silty clay loam or clay about 4 inches thick. It has granular structure. The subsoil is more dense than the surface

layer and has a texture of silty clay. Both the surface layer and the subsoil are nonlimy and show signs of wetness.

Where suitable outlets are available, surface drainage can be installed. Improved surface drainage improves the yields of small grains and makes it easier to till this soil. Good yields of small grains can be expected where drainage is adequate. This soil is not suitable for trees. (Capability unit IIIw-4, drained; capability unit Vw-WL, if the areas cannot be feasibly drained; Wetland range site)

Duncom Series

The Duncom series consists of dark-colored, nearly level and gently sloping soils that are shallow over limestone. These soils are on the summit of a few large limestone-capped buttes in the southern part of the county. They occur only near the outer edges of the buttes.

The surface layer is black, very friable silt loam that is free of lime and is about 4 inches thick. It has fine crumb structure.

The subsoil is weakly defined and is about 7 inches thick. It is dark-gray, very friable, limy silt loam that has weak prismatic structure.

The subsoil rests on hard, slightly fractured limestone that is 2 to 3 feet thick. The limestone is light gray. It breaks to hard, platy fragments.

The thickness of the surface layer ranges from 3 to 6 inches, and the texture ranges from loam or silt loam to clay loam. In a few places the surface layer is limy. The subsoil ranges from 0 to 9 inches in thickness, and it has a texture of clay loam in some places.

These soils are well drained but have limited moisture-holding capacity. They are slightly susceptible to wind erosion but moderately susceptible to water erosion.

Unlike the shallow soils of the Flasher, Bainville, and Midway series, the Duncom soils are underlain by limestone. They have a thinner surface layer and subsoil than the Little Horn soils, and their profile is less well developed. In Stark County the Duncom soils are mapped only with the Little Horn soils.

Eroded Sandy Land

Eroded sandy land (1 to 9 percent slopes) (Es) consists of severely eroded soils that were originally Lihen loamy fine sand, Vebar fine sandy loam, and Parshall fine sandy loam. These soils have lost all of their surface layer and part of their subsoil through wind erosion. The soil material blown from them has accumulated in a layer as much as 4 feet thick around the edges of fields and along fence lines. This land type is in undulating to hummocky areas of the uplands. The areas are scattered and are generally less than 40 acres in size.

Most areas of this land type have been cultivated. They have since been seeded to tame grasses and legumes or have been abandoned. In the abandoned areas, Russian-thistle, sandbur, and other weedy plants have grown up.

In the areas still under cultivation, perennial grasses can be seeded in the crop residue left from the preceding year, and preparation of a seedbed is not necessary. If no crop residue has been left on the surface, straw should be disked in to prevent the seeds and seedlings from being blown away. Establishing grass on this land type will protect the soils in adjacent areas from damage caused by blowing soil particles. After a cover of perennial vegetation has been established, wind erosion is reduced and this land type is stabilized. This land type is not suitable for trees. (Capability unit VIe-Sa, Sands range site)

Farland Series

In the Farland series are deep, dark-colored, well-drained, loamy soils that are nearly level. These soils are on stream terraces in many parts of the county.

The surface layer is very dark gray or very dark grayish-brown silt loam that is free of lime and is about 5 inches thick. It has fine blocky or granular structure.

The subsoil contains more clay than the surface layer and is dark grayish-brown clay loam or silty clay loam about 22 inches thick. It has moderate to strong prismatic and strong blocky structure, and the structural peds are coated with clay films. The upper part of the subsoil is free of lime, but the content of lime increases with increasing depth to the substratum. Specks and small spots of white lime are prominent in the lower part of the subsoil and in the upper layers of the substratum.

The substratum is friable, calcareous alluvium that is penetrated easily by roots. It consists of several thin layers that range from olive to olive gray in color and from sandy loam to clay loam in texture. In many places the substratum contains thin bands of dark-colored alluvium.

The thickness of the surface layer ranges from 3 to 6 inches, and the texture is loam instead of silt loam in some places. The thickness of the subsoil ranges from 18 to 32 inches.

The Farland soils are somewhat similar to the Morton soils, but they developed in friable, stratified, loamy alluvium instead of in less permeable material weathered from soft shale. They have a thinner surface layer and contain more clay than do the Arnegard and Parshall soils. The Farland soils lack the thick layer of gravelly material that is just beneath the subsoil of the Manning soils. They are less clayey and dense than the Savage soils and have a thinner profile than the Grail soils.

The Farland soils are highly fertile and are among the most productive soils in the county. They are used mainly for such crops as small grains and corn. Where good irrigation water is available, these soils are well suited to gravity or sprinkler irrigation.

Farland silt loam, gently sloping (3 to 6 percent slopes) (FaB).—This soil is on short side slopes along the edges of terraces near the main tributaries of the Heart River. The areas are small and scattered. In some places 25 to 75 percent of the surface layer has been lost through erosion. Approximately 95 percent of the acreage is slightly or moderately eroded Farland silt loam and about 5 percent is Arnegard silt loam.

The surface layer of this Farland soil is very dark grayish-brown silt loam about 4 inches thick. Tillage has mixed part of the subsoil into the surface layer. The subsoil is dark grayish-brown silty clay loam about 20 inches thick. Lime is at a depth of about 24 inches.

This soil is productive and is suited to all the crops commonly grown in the county. Its susceptibility to erosion is the main limitation. Where the stubble from

crops is left standing on the surface over winter, however, or where tillage is used that leaves most of the stubble on or near the surface, erosion is not a hazard. This soil is good for trees. (Capability unit IIIe-6, Silty range site)

Farland silt loam, sloping (6 to 9 percent slopes) (FaC).—This soil is on the sloping edges of terraces in scattered areas along the Heart River. In about one-third of the acreage, water erosion has removed from 25 to 75 percent of the surface layer.

About two-thirds of the acreage is cultivated, and the rest is in native pasture. In many of the cultivated areas, the slopes are short and are more suitable for permanent hay than for cultivated crops. This is especially true when the adjacent soils are stripcropped on the contour. This soil is good for trees. (Capability unit IIIe-6, Silty range site)

Farland, Arnegard and Grail silt loams, level (0 to 3 percent slopes) (FgA).—The soils of this complex are so intricately mixed that it is not practical to map them separately. They are in and adjacent to the main stream valleys of the county. About 60 to 70 percent of the complex is Farland silt loam, 15 to 20 percent is Grail silt loam, 10 to 15 percent is Arnegard silt loam, and another 10 to 15 percent is Straw loam.

The Farland soil has a surface layer of silt loam about 5 inches thick, underlain by a subsoil of clay loam about 22 inches thick. Just below the subsoil is limy material. The Arnegard and Grail soils have a surface layer of black silt loam about 9 inches thick, and a subsoil about 30 inches thick. The Arnegard soil has a subsoil of nonlimy loam, and the Grail soil has a subsoil of silty clay loam.

These are among the most productive soils in the county, and they have the fewest limitations. They are well suited to all of the crops commonly grown in the county, and nearly all of the acreage is used to grow spring wheat, barley, oats, and corn. Several cropping systems are suitable. These soils have been only slightly eroded by wind and water, but there is a slight hazard of erosion in unprotected fields. Fields wider than 40 rods need to be protected from wind erosion by leaving about half of the stubble on the surface during the winter months. These soils are excellent for trees. (Capability unit IIc-6, Silty range site)

Flasher Series

The Flasher series consists of sandy, sloping to steep soils that are shallow over soft and moderately hard sandstone. These soils are widely distributed over the county.

The surface layer is generally dark grayish-brown or very dark grayish-brown fine sandy loam. It is very friable and is free of lime or is only slightly calcareous. This layer has crumb or weak, fine, subangular blocky structure and is about 4 inches thick.

In most places a subsoil layer having about the same texture as the surface layer is absent. Where this layer occurs, it is about 7 inches thick. The subsoil is noncalcareous and has weak, coarse, prismatic and medium blocky structure. The upper part is dark grayish brown, but the color grades to a light brownish gray or olive gray in the lower part.

The underlying material contains alternating layers of soft and moderately hard sandstone and a few roots. Both the hard and soft sandstones are massive if they have not been disturbed.

The surface layer ranges from fine sandy loam to loamy fine sand in texture, from grayish brown to very dark grayish brown in color, and from 2 to 9 inches in thickness. Some areas of Flasher soils have a subsoil that is 3 to 10 inches thick. In other places the surface layer rests directly on weathered sandstone. Where there is a weakly expressed subsoil, its texture ranges from fine sandy loam to loamy sand. The underlying material is limy in some places.

These soils are moderately permeable to water but have excessive surface drainage. They are somewhat droughty because of the excessive runoff and moderately low available moisture capacity. Natural fertility is low.

The Flasher soils occur with the Bainville and Chama soils, but they are more sandy than those soils. Their surface layer is thinner than that of the Lihen, Vebar, and Parshall soils, and their subsoil, where evident, is thinner.

The Flasher soils are used mainly for pastures of native grass. They are not well suited to cultivated crops, because they are droughty and susceptible to erosion by wind and water.

Flasher sandy loam, sloping (6 to 9 percent slopes) (FlC).—About 50 to 65 percent of this mapping unit is Flasher sandy loam or Flasher loamy fine sand; 15 to 25 percent is Vebar fine sandy loam; and 10 to 20 percent is Lihen loamy fine sand. The areas are gently sloping and sloping. They are in undulating uplands where the hills are less than 15 feet high. The Flasher soils are mainly on the sides of the hills and on the crests of the ridges. The Vebar and Lihen soils are in the less sloping areas between the ridges and are deeper than the Flasher soils. In about 20 percent of the acreage, the soils of this unit have been moderately or severely eroded by wind.

The surface layer is as thick as 6 inches in some places, but all of the original surface layer has been lost in other places. The texture of the surface layer ranges from fine sandy loam to loamy fine sand. The thickness of the subsoil ranges from zero to 20 inches. In places broken sandstone bedrock crops out at the surface.

The soils of this unit are better suited to hay and pasture than to cultivated crops, but about half the acreage is in cultivated fields. Areas that are now cultivated are best managed by seeding to adapted perennial grasses. If a mulch of straw is used to cover the seedbed while the surface is bare, a more successful stand of grass will be obtained. The soils of this unit are not suited to trees. (Capability unit VIe-TSy, Thin Sandy range site)

Flasher complex (9 to 35 percent slopes) (Fm).—This mapping unit consists mainly of Flasher soils that are shallow over sandstone (fig. 6) and of deep, moderately sandy soils of the Vebar, Parshall, and Lihen series. These soils are on the sides of hills and on steep buttes. The slopes range from 9 to 35 percent but are mainly between 9 and 15 percent. The Flasher soils occupy 55 to 65 percent of the acreage, Vebar and Lihen soils occupy 15 to 25 percent, and Parshall soils occupy 10 to 15 percent. In places small areas of Arnegard loam are in swales

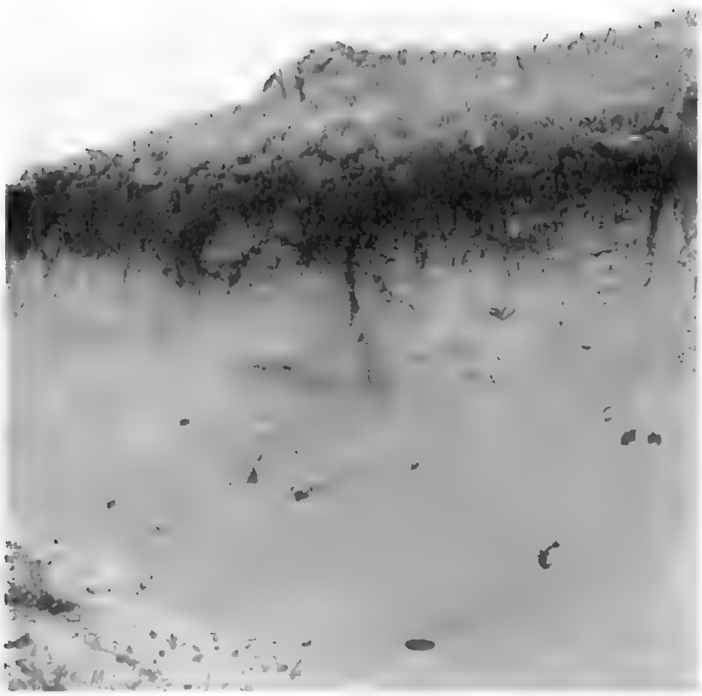

Figure 6.—**An exposed cut in an area of Flasher fine sandy loam. The underlying material is soft sandstone.**

between the steep slopes. The soils of this mapping unit are extensive in Stark County and are mainly in the central and southeastern parts.

The Flasher soils have a surface layer of dark grayish-brown fine sandy loam about 5 inches thick. They have a thin subsoil of fine sandy loam in some places. In other places the surface layer rests directly on the underlying soft sandstone. Lime occurs below a depth of 10 inches in some areas. In other places these Flasher soils are noncalcareous to a depth of 50 inches. The sandstone, below a depth of about 20 inches, restricts the depth to which roots can penetrate.

The Vebar, Parshall, and Lihen soils have profiles like the ones described for their respective series. Their surface layer and subsoil range from fine sandy loam to loamy fine sand in texture and have a combined thickness greater than 20 inches. All of these soils are deep and moderately sandy or sandy, are noncalcareous, and take in water readily.

Native grasses make good yields of forage on these soils if grazing is moderate and good range management is used. Most of the acreage is in native pasture. The soils of this complex are not suited to trees. (Capability unit VIe-TSy, Thin Sandy range site)

Flasher-Rock outcrop complex (15 to 40 percent slopes) (Fr).—This is a complex that consists mainly of shallow, sandy Flasher soils and of ledges and ridges of exposed sandstone. It is in areas of strongly sloping to steep uplands. Included in mapping are scattered areas of deep, moderately sandy Vebar and sandy Lihen soils on the lower part of the steep slopes and in the adjacent swales and drainageways. The soils are mainly on escarpments or along the edges of the valleys of the Heart and Little (Branch of) Knife Rivers. The slopes range from 15 to 40 percent but are mainly between 20 and 35 percent.

The Flasher soils are steep and have a thin surface layer of fine sandy loam over weathered sandstone. They have a good cover of native grass. Little or no soil material covers most areas of the sandstone outcrops, and there is only a sparse stand of native grass. The hazard of erosion by wind and water is severe.

The soils of this complex are used for range or pasture. They are not suitable for trees. (Capability unit VIIs-TB, Thin Breaks range site)

Gallatin Series

The Gallatin series consists of very dark colored, nearly level soils on bottom lands along the larger streams. These soils are imperfectly drained. They are in shallow depressions or in shallow overflow channels.

The surface layer is very dark brown or black, friable clay loam about 13 inches thick. It has crumb structure and is noncalcareous.

Beneath the surface layer is dark grayish-brown, friable loam or clay loam about 20 inches thick. This material has mottles of brown and dark yellowish brown caused by excessive wetness. The structure of the subsoil is coarse angular blocky, but the aggregates break horizontally to plates. In most places lime is in the lower part of the subsoil.

Beneath the subsoil is mottled stream-deposited alluvium of limy loam or clay loam. This material is moist during most of the growing season.

The texture of the surface layer ranges from loam to clay loam or silty clay loam, and the thickness ranges from 9 to 18 inches. The color of the surface layer ranges from very dark brown or dark grayish brown to black. The texture of the subsoil ranges from loam or clay loam to silty clay loam, and the thickness of the subsoil ranges from 16 to 26 inches. The amount of lime in the subsoil generally increases with increasing depth. In some places, however, the subsoil contains no free lime, and in other places it is strongly calcareous. The structure in the upper part of the subsoil ranges from weak prismatic to strong blocky. The lower part of the subsoil is massive.

Ponding in the shallow depressions where these soils occur causes somewhat poor surface drainage. At times, these soils have a temporary water table in the lower part of the profile.

The Gallatin soils are darker colored and have poorer drainage than the Havre and Straw soils with which they occur. They are less wet and are less clayey than the Dimmick soils of upland basins. The Gallatin soils are less limy and have a lower water table than the Colvin soils.

The Gallatin soils are used mainly for alfalfa and bromegrass grown for hay, or are cultivated annually and planted to small grains.

Gallatin clay loam (0 to 1 percent slopes) (Ga).—This is the only Gallatin soil mapped in the county. It occurs in shallow, long, narrow depressions that were once a part of the channel systems of the Green and Heart Rivers. These depressions consist of partly filled old stream channels, locally called oxbows or meanders. This soil is often flooded in spring during periods when runoff is

excessive. At times, the floodwaters deposit a thin layer of silty sediment on the surface.

Hay and small grains yield well on this soil in years of normal or below-normal rainfall. In years when higher than normal rainfall is received, seeding is delayed and the stand of alfalfa is likely to be destroyed by ponded water. Excessive ponding does not occur often enough, however, to make this soil unsuitable for tame grasses and legumes. If tame hay is desired, a mixture of bromegrass and alfalfa should be seeded early in fall. This soil is good for trees. (Capability unit Vw–Ov, Overflow range site)

Glendive Series

The Glendive series consists of deep soils that are moderately sandy. These soils are on nearly level bottom lands along the main channels of the Heart and Green Rivers.

The surface layer is very dark grayish-brown, very friable fine sandy loam. It has weak, fine, blocky structure or is single grained, and it is about 10 inches thick.

Just beneath the surface layer are several layers of calcareous, very friable fine sandy loam and loamy fine sand that are single grained or have weak blocky structure. These layers are the former surface layers of soils that have been buried by successive deposits of river sediments. The amount of lime in each of these layers and the texture of the soil material vary greatly from layer to layer. The boundary between the layers is abrupt.

The surface layer ranges from 4 to 12 inches in thickness and has a sandy loam or fine sandy loam texture. In places this layer is slightly calcareous. The middle and lower parts of the profile range from grayish brown to very dark grayish brown in color and from loamy fine sand to loam in texture.

The Glendive soils are moderately well drained. In places, however, they have a temporary water table in the lower part of the profile. Natural fertility is moderate, and these soils are well suited to irrigation. Wind erosion is a hazard where cultivated crops are grown.

The Glendive soils have a texture that is intermediate between that of the Banks soils, which are sandy, and the Havre loams and silty clay loams. They have a lighter colored surface layer than the Parshall soils, and they lack the distinct subsoil that is typical of those soils. The Glendive soils occur with the Straw soils, but they are more sandy than those soils and they have less distinct layers.

The Glendive soils are used mainly for growing small grains, corn, and grasses for tame pasture.

Glendive fine sandy loam (0 to 3 percent slopes) (Gf).—This is the only Glendive soil mapped in the county. It is on the bottom lands of the Heart and Green Rivers and Antelope Creek. The areas are mainly nearly level, but they are gently undulating in places as the result of wind erosion. Small drifts of soil material have collected along fences and along the edges of fields. Streams meanedr through areas of this soil. Once in every 3 years, on the average, this soil is flooded for short periods during the months of April through June.

Where the vegetation consists of the original native grasses, the surface layer is very dark grayish-brown fine sandy loam that is slightly darker than the rest of the profile. Where this soil has been cultivated, it has lost from 25 to 75 percent of the surface layer through erosion. In those areas there are only slight differences in color and structure between the surface layer and the thin layers below. The layers below the surface layer are distinguished by differences in texture and by the amount of lime they contain. The texture of these layers ranges from loam to loamy fine sand.

Included with this soil in mapping are areas of Havre loam. This included soil makes up 5 to 20 percent of the acreage in the mapping unit.

Wind stripcropping and good management of crop residue are needed on this Glendive soil. A well-suited cropping system consists of alternate corn and small grains, but this soil is also excellent for alfalfa grown for hay. It is also excellent for trees. (Capability unit IIIe–3, Sandy range site)

Grail Series

In the Grail series are deep, dark-colored soils that are nearly level to sloping. These soils are in swales and drainageways in the uplands. Most of the individual areas are small and scattered, but the total acreage is large enough to be important for farming.

The surface layer is black, friable loam, silt loam, or silty clay loam about 10 inches thick. It is noncalcareous and has granular or crumb structure.

The subsoil is about 24 inches thick and contains more clay than the surface layer. It is very dark grayish-brown, noncalcareous silty clay loam or silty clay that has moderate, medium, prismatic and strong, medium and fine, blocky structure. The subsoil has shiny clay films on the surfaces of the blocks and prisms.

The upper part of the underlying material is strongly calcareous, firm silty clay loam that has moderate blocky structure. The lower part is also firm silty clay loam, but it contains less lime than the upper part and has weak blocky structure. In many places gypsum and other salts are mixed with the lime in the underlying material.

The surface layer ranges from silt loam to silty clay loam in texture, from black or dark grayish brown to very dark brown in color, and from 8 to 14 inches in thickness. The subsoil ranges from clay loam to silty clay in texture and from 17 to 33 inches in thickness. The structure of the subsoil ranges from weak to moderate prismatic and from moderate to strong blocky.

The Grail soils have good surface drainage but moderate to slow permeability. They receive extra moisture in runoff from the adjacent slopes. Their favorable supply of moisture and high fertility make most of them highly productive. The hazard of wind erosion is slight. The hazard of water erosion is slight to moderate, depending on the degree of slope and the amount of runoff water received.

The Grail soils have more clay in their subsoil and underlying material than the Arnegard soils. They are darker colored and have a thicker surface layer and subsoil than the Morton, Regent, and Farland soils.

In this county most areas of Grail soils are cultivated. These soils are generally suitable for all the commonly grown crops.

Grail silty clay loam, level (0 to 3 percent slopes) (GrA).—This soil is widely distributed throughout the

county. Where it has been cultivated, it is slightly eroded.

The surface layer is about 10 inches thick. It is silt loam in some parts of the county and silty clay loam in others. The surface layer has been affected by rill erosion in places. The subsoil is silty clay loam or silty clay about 18 inches thick. Dark-colored films of organic matter and clay on the surfaces of the blocks and prisms make the subsoil almost as dark as the surface layer.

Included with this soil in mapping are small areas of Morton silt loam, Regent silty clay loam, and Belfield loam. These included soils are nearly level.

This Grail soil is well suited to all the crops commonly grown in the county. Most of it has been cultivated. It is highly productive and is resistant to wind erosion. Water erosion is only a moderate hazard. This soil is fair for trees. (Capability unit IIc-6, Silty range site)

Grail silty clay loam, gently sloping (3 to 6 percent slopes) (GrB).—This soil is in swales and drainageways in the uplands. It occurs with areas of Morton silt loam and Regent silty clay loam, and it contains small areas of those soils in many places. As much as 10 to 25 percent of any area mapped as this soil is Morton silt loam or Regent silty clay loam. This soil is more susceptible to water erosion than Grail silty clay loam, level. Some areas are moderately eroded and contain small rills and gullies.

The surface layer is silt loam or silty clay loam about 8 inches thick. The subsoil is silty clay loam about 17 inches thick. The underlying material is limy and contains scattered pockets of salts.

Most of this soil is cultivated. Small grains, corn, and hay are the commonly grown crops, and yields are good. Practices that control water erosion are of primary importance. In drainageways that are actively eroding, grassed waterways will greatly reduce erosion. This soil is fair for trees. (Capability unit IIIe-6, Silty range site)

Grail silty clay loam, sloping (6 to 9 percent slopes) (GrC).—This soil is mainly on the lower part of long slopes in the uplands. It has been slightly eroded by water.

The surface layer is silt loam or silty clay loam about 8 inches thick. The subsoil is silty clay loam about 17 inches thick. The underlying material is limy and contains scattered pockets of salts. Depth to lime is about 25 inches.

Included with this soil in mapping are areas of Morton silt loam, Morton clay loam, and Regent silty clay loam. These included soils make up 20 to 30 percent of the acreage in the mapping unit.

This Grail soil is fair to good for crops, if adequate practices are used to control water erosion. It is fair for trees. (Capability unit IIIe-6, Silty range site)

Grail soils, saline (1 to 5 percent slopes) (Gs).—The soils of this unit occupy small areas in long, narrow drainageways in the silty and sandy uplands. They are saline and are affected by seepage. The water table is commonly at a depth of 20 to 30 inches during the early part of the growing season. Erosion has been slight to moderate.

The surface layer is silt loam or silty clay loam about 10 inches thick. It is generally dark gray or black when moist. When it is dry, some patches have a light-grayish color because of the accumulation of salts. The subsoil is mainly grayish-brown silty clay loam, but parts of the subsoil have a texture of silty clay in some places. The lower part of the subsoil contains a large amount of lime, and salt crystals have accumulated in pockets.

Included with these soils in mapping are small areas of Arnegard loam and Grail silt loam.

Because of the moderate content of salts, and because of the location, mainly in intermittent drainageways, the Grail soils of this unit are best seeded to salt-tolerant grasses and managed as grassed waterways. About half of the acreage is cultivated, and the rest is already in grassed waterways or in pasture. Where the soils are cultivated, spotty germination and spotty emergence show the effects of the salts. These soils are not suitable for trees. (Capability unit IIIws-4, Subirrigated range site)

Grail-Rhoades silty clay loams, level (0 to 3 percent slopes) (GtA).—In this soil complex are deep, dark-colored Grail and Belfield silty clay loams mixed with lighter colored, shallow Rhoades soils. About 30 to 40 percent of the acreage is Grail silty clay loam or Grail silt loam, 20 to 35 percent is Rhoades loam, and 20 to 30 percent is Belfield silty clay loam. These soils are in swales and drainageways in the uplands. They occupy small areas scattered throughout the county.

The profile of the Grail soil is like the one described for the Grail series. A typical profile of the Belfield and Rhoades soils is described under the Belfield and Rhoades series.

These soils take in water slowly but have good surface drainage. Erosion is slight to moderate. In cultivated fields and pastures made up partly or entirely of these soils, there are crusted, grayish slickspots that contain a pan. The Rhoades soil is mainly in these spots or patches. It not only has poor structure but also has salty material in the subsoil that restricts the growth of plants.

About 60 percent of the acreage in this complex is in cultivated crops. The best cropping system for these soils is one in which summer fallow is alternated with small grains. Commercial fertilizer should be applied according to the needs of the crop to be grown. Erosion by wind and water can be significantly reduced by stripcropping and by stubble mulching when the soils are fallow. These soils are not suitable for trees. (Capability unit IIIs-5P, Silty range site)

Grail-Rhoades silty clay loams, gently sloping (3 to 6 percent slopes) (GtB).—This soil complex consists of areas of deep, dark-colored Grail and Belfield silty clay loams mixed with areas of light-colored, shallow Rhoades loam. From 35 to 45 percent of the complex is Grail silty clay loam, 20 to 35 percent is Rhoades loam, and 15 to 25 percent is Belfield silty clay loam. These soils occur in drainageways and swales with areas of Morton silt loam and Regent silty clay loam. In most of the areas, the soils are slightly to moderately eroded. In places there are gullies 1 to 2 feet deep.

The Grail and Belfield soils have a surface layer that is about 8 inches thick and a friable subsoil that is 20 to 25 inches thick. The Rhoades soil has a light-colored surface layer 2 to 5 inches thick and a very firm or hard subsoil about 8 inches thick. It has salty material just below the thin subsoil.

Most of this complex is cultivated. The soils are better suited to the commonly grown small grains than to other crops, but they should be left fallow in summer every other year. Contour stripcropping, grassed water-

ways, and stubble-mulch tillage are needed to adequately control erosion. These soils are not suited to trees. (Capability unit IIIe-6P, Silty range site)

Gravelly Land

Gravelly land (3 to 30 percent slopes) (Gv) consists mainly of shallow, gravelly soils on high terraces and on the tops of steep valley escarpments along the Heart and Green Rivers. About 50 to 75 percent of the acreage is gravelly soil material, 15 to 30 percent is Bainville loam, and 10 to 20 percent is Manning loam. In most places the slopes are between 12 and 20 percent. Surface runoff is excessive, and the available water capacity is low.

In a typical area of this land type, the soil material is loam or sandy loam to a depth of about 3 inches. The loam or sandy loam is underlain by several inches to several feet of loamy gravel. In places only the upper part of the slope is gravelly. In those areas the lower part of the slope is occupied by Bainville soils. The Bainville soils have a loamy surface layer about 4 inches thick underlain by silty shale.

Several areas of this land type have been mined for gravel and sand. As a result, there are pits in some places and piles of stripped soil material, or overburden, that accumulated during the mining operations. In areas that are not mined, this land type is used mainly for native pasture. This land is too steep and droughty for cultivation. Leveling the piles of spoil material and reseeding the stripped areas will improve the land for grazing. The land is not suitable for trees. (Capability unit VIIs-SwG, Shallow to Gravel range site)

Havre Series

Deep loams and silty clay loams that are nearly level make up the Havre series. These soils are on bottom lands in the valleys of the Heart and Green Rivers. They developed in recent water-laid sediments.

The surface layer is very dark grayish-brown, friable, slightly calcareous loam or silty clay loam about 10 inches thick. It has weak, fine, blocky structure or is single grained.

In the lower part of the profile are one or more dark-colored bands or layers that are surface soils that have been buried by more recent stream sediments. The amount of lime and the texture and color of the soil material vary greatly from one layer to another, and the boundary is abrupt between the layers.

The surface layer ranges from 4 to 12 inches in thickness. The middle and lower parts of the profile contain a thin layer of fine sandy loam or loamy fine sand in a few places, although they generally have a texture of loam or silt loam. In places the surface layer and the lowest part of the profile are noncalcareous.

These soils are moderately well drained. At times, some areas have a temporary water table in the lower part of the profile. Natural fertility is moderate, but there is a slight hazard of wind erosion. These soils are well suited to irrigation.

The Havre soils occur with the Glendive and Banks soils, but they contain more silt and clay than those soils. They have weaker structure and lack the distinct subsoil that is typical of the Straw, Farland, and Parshall soils.

The Havre soils are used for growing small grains and tame hay.

Havre loam (0 to 3 percent slopes) (Ha).—This is a deep soil that occurs along the Heart and Green Rivers and their main tributaries (fig. 7). It is on the lowest benches of the bottom lands, adjacent and parallel to the channel of the stream. About once every 3 years, this soil is flooded for short periods.

The surface layer is dark grayish-brown, friable loam about 9 inches thick. It is underlain by several layers of loam or silt loam. In some places the middle and lower parts of the profile are lighter colored, and in some places they are darker colored than the surface layer. Most parts of the profile contain lime.

Included with this soil in mapping are a few areas of Straw loam and Glendive fine sandy loam. The Straw soil makes up 5 to 15 percent of the acreage mapped as this soil, and the Glendive soil makes up 0 to 10 percent.

This Havre soil is well suited to corn grown for silage and alfalfa grown for hay. Nearly all of it is cultivated. Wind erosion is controlled by growing corn and small grains in alternate strips less than 25 rods wide. These crops should be grown in a 2-year rotation. Good response is received from a fertilizer high in content of nitrogen and phosphate. This soil is excellent for trees. (Capability unit IIe-5, Silty range site)

Havre silty clay loam (0 to 3 percent slopes) (He).—This nearly level soil is on bottom lands along the upper reaches of the Heart River. The surface layer is about 9 inches thick and has granular and fine blocky structure. Below the surface layer are several layers of dark-gray to light brownish-gray fine sandy loam, loam, and silty clay loam. Lime is present in some layers and is absent in others.

Included with this soil in mapping are areas of Havre loam. This included soil makes up as much as 15 percent of the acreage mapped as Havre silty clay loam.

Good yields of tame hay and small grains are obtained. Wind erosion is a slight hazard, but it can be easily controlled by planting the crops in narrow fields or by wind stripcropping and by stubble mulching when the soils are fallow. This soil is excellent for trees. (Capability unit IIc-4, Clayey range site)

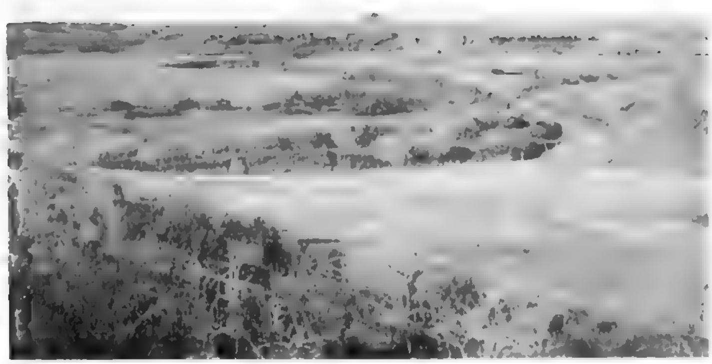

Figure 7.—**Havre, Straw, and Glendive soils in nearly level areas adjacent to the Heart River. Bainville soils are on the steep slopes in the background.**

Hoven Series

In the Hoven series are somewhat poorly drained, clayey soils in closed, shallow depressions in the uplands. These soils are nearly level. The areas are scattered throughout the country.

The surface layer is highly leached, noncalcareous, friable clay loam that is dark gray or black when moist and gray when dry. It has thin platy structure and is about 2 inches thick. The surface layer has a weak crust when these soils are dry. An abrupt boundary separates the surface layer from the subsoil.

The subsoil is dark-gray, dense silty clay about 27 inches thick. It has moderate, coarse, prismatic and strong blocky structure. The upper part is free of lime, but the lower part contains nests of lime. The pan characteristics of the subsoil are caused partly by the clayey texture and partly by the effect of the salts from the underlying material.

The underlying material is massive, dense clay or silty clay that has common mottles of brown, yellow, and gray. It is calcareous and contains many pockets of salt crystals. Few roots penetrate this layer.

The surface layer ranges from ½ inch to 3 inches in thickness and from loam to clay loam or silty clay loam in texture. The structure of the subsoil is very coarse prismatic or columnar in some places. In places the texture of the subsoil is clay instead of silty clay. The subsoil ranges from 24 to 32 inches in thickness, and the lower part contains salts and lime in some places.

These soils have slow or very slow internal drainage. They lose little excess surface water through percolation. Most of this water evaporates or is used by plants.

The Hoven soils have a thinner surface layer and are more salty than the Dimmick soils and they are not so poorly drained. They have a thicker and a more coarse-structured subsoil than the Rhoades soils, and they are saline at a greater depth.

The Hoven soils are better suited to grass than to tilled crops, and they are used mainly for native hay or pasture. Some fields of these soils that were formerly cultivated have been reseeded to grass. In many places artificial drainage can be installed, but management will still be difficult and yields will be reduced by the poor tilth and high content of salts.

Hoven soils (0 to 1 percent slopes) (Ho).—These are the only Hoven soils mapped in the county. They occur in small, scattered basins, or depressions, in the uplands. The material in which these soils developed is clayey sediments that eroded from the surrounding slopes and partly filled the basins.

The surface layer of these soils is thin and has a texture of silty clay loam in most places. Where tillage has mixed clay from the subsoil into the surface layer, the present surface layer has a texture of silty clay.

These soils receive extra moisture from runoff that is trapped in the basins. Surface drainage is needed to improve them for cultivated crops. After these soils are drained, they are better suited to wheat and barley than to other field crops. Where these soils are in native hay or pasture, the dominant grass is western wheatgrass and yields of forage are good. The soils are not suitable for trees. (Capability unit IVws-4, Overflow range site)

Lefor Series

In the Lefor series are deep, well-drained, moderately sandy soils that are undulating or sloping. These soils are on uplands in the central part of the country.

The surface layer is very dark grayish-brown fine sandy loam about 4 inches thick. It has weak, fine, blocky structure, is easily worked, and contains no lime.

The upper part of the subsoil is brown or dark grayish-brown sandy clay loam, and the lower part is light yellowish-brown sandy clay loam. The subsoil is about 26 inches thick. It has coarse prismatic and blocky structure, is noncalcareous, and is easily penetrated by roots. The surfaces of the prisms have thin to thick films, or coatings, of clay or organic matter.

The underlying material is in two or three layers, which are separated mainly as a result of differences in color. It is mainly pale-olive or pale-yellow, friable fine sandy loam that weathered from soft sandstone. This material is limy. It is massive but breaks to single grains if it is disturbed. Roots penetrate it readily.

In some places the surface layer is as much as 7 inches thick. The thickness ranges from 0 to 7 inches, however, for erosion has removed all of the original surface layer in places. The subsoil ranges from 18 to 30 inches in thickness. In some areas its lower part has a texture of fine sandy loam. The color of the subsoil ranges from light yellowish brown to dark grayish brown, depending on the elevation and on the kind of underlying material.

These soils have good internal drainage and are permeable. They are highly susceptible to erosion by wind and water, however, and are moderately low in natural fertility.

The thin surface layer and the subsoil of sandy clay loam distinguish the Lefor soils from the Vebar and Parshall soils. The Lefor soils are less sandy and have a more distinct subsoil than the Lihen soils. Unlike the Morton soils, which have a surface layer and underlying material of silt loam and clay loam, the Lefor soils have a surface layer and underlying material of fine sandy loam.

About three-fourths of the acreage of Lefor soils is used for growing wheat, barley, and corn for silage. Some areas are still in pastures consisting of native grasses or have been reseeded to tame grasses.

Lefor fine sandy loam, undulating (2 to 6 percent slopes) (LeB).—This is the most extensive of the Lefor soils. It is mainly near the village of Lefor, but a smaller area is northeast of Dickinson.

The surface layer is fine sandy loam that is about 5 inches thick and is easily worked. The subsoil is friable sandy clay loam that has strong prismatic structure and is about 27 inches thick. Lime occurs only in some places in the underlying material.

Included with this soil in mapping are nearly level areas of Lefor fine sandy loam. Also included are areas of Morton loam that make up 5 to 15 percent of some areas mapped as this soil.

This Lefor soil is highly susceptible to wind erosion, and the more sloping areas are susceptible to water erosion. Erosion is likely to be especially critical when the surface is not protected by a cover of plants or has only slight protection. Nearly all of the acreage is cultivated.

Crop residue should be left standing in winter and left on the surface when this soil is fallow in summer. Tilling across the slope reduces runoff. This soil is fair for trees. (Capability unit IIIe-3M, Sandy range site)

Lefor fine sandy loam, undulating, eroded (2 to 6 percent slopes) (LeB2).—This soil is mainly in the south-central part of the county. It is mostly in areas where wind erosion and water erosion have removed a part or all of the surface layer. Tillage implements have mixed a part of the subsoil into the surface layer. The soil material blown from this and from other soils has accumulated along fences and along the boundaries of fields. A few shallow blowout pits occur in some fields.

The surface layer is variable and ranges from 0 to 6 inches in thickness. In most places the crest of the short, undulating slopes where this soil occurs have eroded more than the side slopes and nearly level areas. The upper part of the subsoil is sandy clay loam, and the lower part is fine sandy loam. The subsoil is about 25 inches thick.

Included with this soil in mapping are areas of Morton loam. This included soil makes up 5 to 15 percent of some areas mapped as this soil.

Most of this Lefor soil is cultivated, but many areas that were formerly cultivated have been reseeded to tame grasses. In cultivated fields wind stripcropping protects this soil from further excessive erosion. Leaving crop residue on the surface when this soil is summer fallowed also provides protection. More fertilizer is likely to be needed on this soil than on a similar soil that is not eroded. This soil is fair for trees. (Capability unit IIIe-3M, Sandy range site)

Lefor fine sandy loam, sloping (6 to 12 percent slopes) (LeC).—This soil is in areas that are small and scattered. It has been slightly affected by water erosion.

The surface layer is dark grayish brown and is about 5 inches thick. The subsoil is thinner than the one in the profile described for the series, or about 22 inches thick.

Included with this soil in mapping are small areas of Bainville loam. Also included are small areas of Flasher fine sandy loam.

This Lefor soil is better suited to hay and pasture than to cultivated crops, and most of the acreage is in pastures of native grasses. The areas that are now cultivated should be seeded to adapted tame grasses. This soil is not suitable for trees. (Capability unit IVe-3, Sandy range site)

Lefor fine sandy loam, sloping, eroded (6 to 12 percent slopes) (LeC2).—This soil has been eroded by both wind and water, and rills and small gullies are prominent in many places. In some places all of the original surface layer has been lost through erosion, but the surface layer is about 3 inches thick in most places. Tillage has mixed a part of the dark grayish-brown subsoil into the surface layer.

Included with this soil in mapping are a few severely eroded areas where all of the surface layer and part of the subsoil have been lost through erosion. Blowout spots occur in those areas. Also included are a few small areas of Bainville and Flasher soils.

This Lefor soil is mainly in cultivated fields, but some of the areas have been reseeded to tame grasses. Seeding adapted native grasses into crop residue and annual weeds is a good method of improving the eroded or severely eroded areas. This soil is not suitable for trees. (Capability unit IVe-3, Sandy range site)

Lihen Series

In the Lihen series are deep, excessively drained, sandy soils that are nearly level to rolling. These soils are on uplands and stream terraces in several parts of the county.

The surface layer is dark grayish-brown, very friable loamy fine sand about 8 inches thick. It has weak crumb structure or is single grained and is noncalcareous.

The subsoil is generally light olive-brown or dark-brown, very friable loamy sand, loamy fine sand, or sand that has very weak prismatic and blocky structure. It is about 26 inches thick, and like the surface layer, it is noncalcareous. In many places the subsoil contains thin layers of soil material that are as dark or darker than the surface layer. These thin layers are the former surface layer of an old soil that has been buried under wind-blown sandy material. A two-storied profile is common in the soils of this series, and the lower part of the profile is that of the buried soil.

In some places the underlying material is loamy fine sand or sandy loam weathered from soft sandstone. In other places it is wind-deposited loamy fine sand that has blown in from other areas. This underlying material is generally free of lime and can be penetrated readily by roots.

The surface layer has textures of loamy sand and loamy fine sand, and its thickness ranges from 2 to 14 inches. The subsoil varies widely in color and texture. In some places it contains thin bands of fine sandy loam or loam. In places layers of gravelly loam less than 6 inches thick occur in both the subsoil and underlying material. The thickness of the subsoil ranges from 20 to 35 inches.

These soils have rapid permeability and excessive internal drainage. They are somewhat droughty because of their low available water capacity. The soils have moderately low natural fertility and are highly susceptible to wind erosion.

The Lihen soils occur with the Flasher and Vebar soils. They are deeper than the Flasher soils and are lighter colored, have weaker soil structure, and contain more sand than the Vebar and Parshall soils. The Lihen soils are coarser textured and contain less lime than the Glendive soils.

The nearly level and gently undulating areas of Lihen soils are cultivated. Most of the undulating and strongly sloping or rolling areas remain in native grass. In most fields where these soils have been cultivated, they are moderately eroded.

Lihen loamy fine sand, undulating (2 to 6 percent slopes) (LfB).—This soil is on uplands and high stream terraces, and the largest areas are south of Gladstone. Most of the slopes are short. This soil is gently undulating in many places. Many of the areas are eroded.

The thickness of the surface layer varies greatly within a distance of 50 feet. In places 75 to 100 percent of the surface layer has been lost through erosion. In other eroded areas of this soil, the surface layer is only 2 to 4 inches thick. These eroded areas adjoin areas where the surface layer is 8 to 10 inches thick. The surface layer is

lighter colored in areas that are eroded than in the noneroded areas.

The subsoil is light olive-brown or dark-brown loamy fine sand about 27 inches thick. In a few places the lower part of the underlying material contains lime.

Included with this soil in mapping are small areas of Vebar and Parshall fine sandy loams. Also included are small areas of Arnegard loam.

A cropping system that includes perennial grasses grown for several years, and small grains grown for short periods, is best suited to this Lihen soil. Wind stripcropping and good management of crop residue are important during periods when this soil is cultivated. In the fields where wind stripcropping is practiced, the strips should be narrow. Corn ought to replace summer fallow in the cropping system. This soil is not suited to trees. (Capability unit IVe-2, Sands range site)

Lihen-Flasher loamy fine sands, rolling (6 to 15 percent slopes) (LlC).—This is a complex of deep and shallow, sandy soils in rolling or undulating areas. The largest area is southwest of the Heart River, where the river bends to the southeast near Gladstone. The Flasher soils occur on the crests and on the upper part of the slopes. They are shallow, and sandstone is exposed in a few places.

The surface layer of the soils of this complex is about 4 inches thick. The subsoil of the Lihen soil is 10 to 27 inches thick, but the subsoil of the Flasher soil is not clearly expressed.

Included with these soils in mapping are a few areas of steep Bainville and Midway soils.

Most of this complex is in native pasture. Gullies have formed where trails made by cattle and sheep have destroyed the cover of grass. Deferring grazing for a season improves the areas where the condition of the range is fair or poor. Important in maintaining a vigorous stand of native plants is proper range management, including moderate use and good distribution of grazing. These soils are not suited to trees. (Capability unit VIe-Sa, Sands range site)

Little Horn Series

Moderately deep, dark-colored, nearly level and gently sloping soils make up the Little Horn series. These soils are on the summit of several large buttes in the southern part of the county.

The surface layer is black, friable silt loam that is about 6 inches thick and is free of lime. It has crumb and fine blocky structure.

The subsoil contains slightly more clay than the surface layer and is generally very dark gray or dark grayish-brown, friable silty clay loam. It is about 20 inches thick and is strongly calcareous. The structure of the subsoil is mainly strong, coarse, prismatic and strong, medium, blocky. In places thick, dark-colored clay films are on the surfaces of the prisms and blocks.

An abrupt boundary separates the subsoil from the underlying material of hard, light-gray limestone. The limestone contains fine cracks and fissures where a few roots have penetrated.

The thickness of the surface layer ranges from 4 to 9 inches. In places the surface layer is very dark gray, and in some places its texture is loam. The color of the subsoil ranges from very dark gray to light brownish gray or dark grayish brown, and the thickness of the subsoil ranges from 10 to 25 inches. The subsoil is noncalcareous in some places. In some areas the upper part of the limestone is broken into pieces and has a powdery consistence. The material in this slightly weathered layer rests directly on hard limestone.

These soils are well drained and take in water at a moderate rate. They are slightly susceptible to erosion by wind and water.

The Little Horn soils occur with the Duncom soils. In contrast to the Duncom soils, which have only a thin subsoil or no subsoil, they have a thick and distinct subsoil. The Little Horn soils have a thinner profile than the Morton and Farland soils, and unlike those soils, they are underlain by indurated bedrock.

About 60 percent of the acreage of Little Horn soils is in native grass. The rest is used for small grains, which make good yields.

Little Horn and Duncom soils, level (0 to 3 percent slopes) (LnA).—The soils of this undifferentiated unit are on the tops of several of the higher buttes. The largest acreage is on Long Butte, southeast of Richardton, and on three or four other buttes near the Hettinger County line. From 75 to 90 percent of the acreage is Little Horn silt loam or loam. Shallow Duncom soils, near the edges of the flat-topped buttes, make up 10 to 25 percent of the acreage. The amount of runoff is small, and the soils of this unit are only slightly eroded.

The Little Horn soils have a dark-colored surface layer of loam or silt loam. They have a distinct subsoil that has strong prismatic structure and is limy in most places below a depth of 6 to 10 inches. The subsoil rests on a thin layer of partly weathered limestone that has been broken into fragments. Massive limestone bedrock is at a depth of 14 to 26 inches. The Duncom soils have a surface layer similar to that of the Little Horn soils, but their subsoil is thin over limestone.

The soils of this unit are fair for trees. (Capability unit IIIs-6R, Silty range site)

Little Horn and Duncom soils, gently sloping (3 to 6 percent slopes) (LnB).—The soils of this unit occur with areas of Little Horn and Duncom soils, level. They are fair for trees. (Capability unit IIIs-6R, Silty range site)

Manning Series

In the Manning series are deep and moderately deep, well-drained soils that are nearly level to sloping. These soils developed in loamy alluvium over gravelly alluvial material (fig. 8). They occur in scattered areas on high stream terraces in all parts of the county.

The surface layer is very dark grayish-brown, friable loam or fine sandy loam about 6 inches thick. It is noncalcareous and has fine blocky and crumb structure.

The subsoil is generally dark grayish-brown, friable, noncalcareous loam about 18 inches thick. In many places, however, the upper part is as dark colored as the surface layer. The subsoil contains a few pebbles and has distinct prismatic and blocky structure. The prisms are coated with dark-colored films of clay and organic matter that are either patchy or continuous.

An abrupt boundary separates the subsoil from the substratum of gravelly coarse sandy loam or loamy gravel. The substratum is in two layers. The upper part is about 6 inches thick. It is strongly calcareous and has many

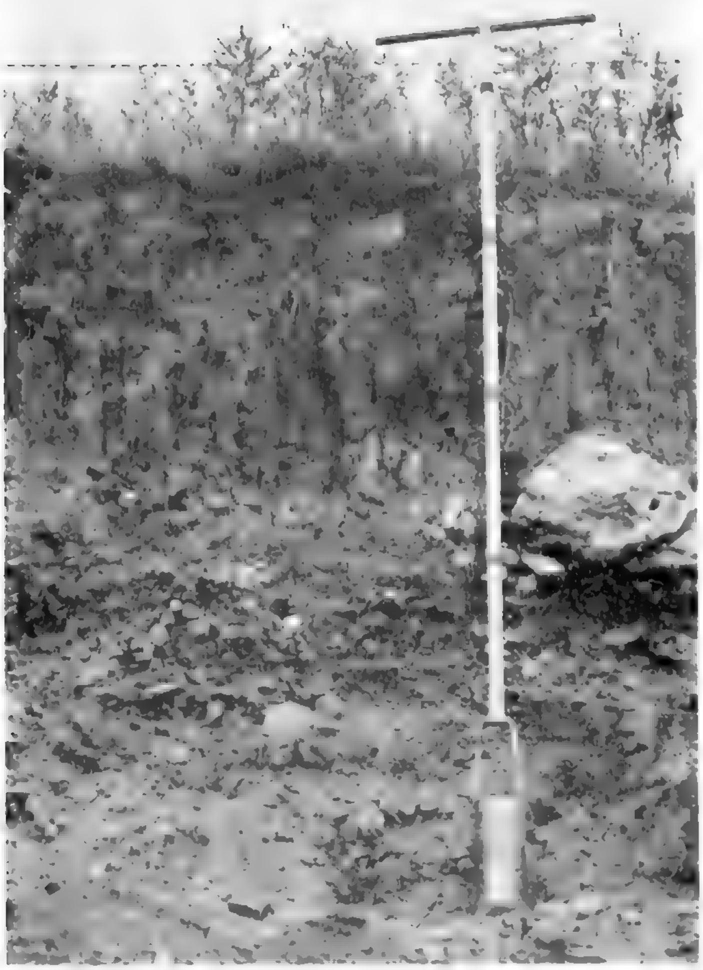

Figure 8.—**Profile of Manning fine sandy loam. Large stones are numerous in the gravelly substratum.**

spots of white lime between the pebbles. The lower part is only slightly calcareous and contains less gravel and more coarse and medium sand.

The surface layer ranges from 4 to 7 inches in thickness, and the subsoil, from 12 to 30 inches. The texture of the subsoil is light clay loam in some places. The total thickness of the substratum ranges from 16 inches to several feet. In places the material in the substratum includes sandy gravel, medium and coarse sands, or gravelly loam.

Permeability is moderate or moderately rapid, and the available moisture capacity ranges from fair to good, depending on the thickness of the subsoil.

The Manning soils occur with the Farland soils, but they have a thinner subsoil that contains less silt and clay, and they have a thick, gravelly substratum. This thick, gravelly substratum distinguishes the Manning soils from the Vebar, Parshall, and Lihen soils.

The Manning soils are suited to corn, small grains, and grass, and most of the acreage is cultivated. These soils are well suited to irrigation, but lack of available water limits the development of an irrigation system. Wind erosion and droughtiness are the main hazards.

Manning loam, level (0 to 3 percent slopes) (MaA).—This soil is in scattered areas on the higher terraces, or benches, along the Heart and Green Rivers. It is only slightly eroded. In most places the slopes are 1 to 2 percent, but they are 3 percent in a few areas along the edges of the terraces. This soil is more productive than the Manning fine sandy loams because it has a thicker subsoil and more clay in the surface layer.

The surface layer is very dark grayish-brown loam about 7 inches thick, and the subsoil is dark grayish-brown loam about 27 inches thick. Beneath the subsoil are layers of gravelly loam and sandy gravel that contain lime.

Included with most areas of this soil in mapping are areas of Manning fine sandy loam, level. This included soil makes up 5 to 20 percent of the acreage in this mapping unit.

This Manning loam is highly productive, and most of the acreage is cultivated. It is not only well suited to field crops and pasture, but it is also good for trees. (Capability unit IIe-5, Silty range site)

Manning fine sandy loam, level (0 to 3 percent slopes) (McA).—Areas of this soil are scattered throughout the higher parts of the uplands and along the principal streams and stream valleys in the county. This soil developed mainly in sediments deposited by the fast-moving waters of streams that presently drain or that formerly drained the area. The slopes are mainly 1 to 2 percent.

The surface layer is very dark grayish-brown fine sandy loam or loam about 6 inches thick. The subsoil is dark grayish-brown loam about 19 inches thick. Both of these layers are free of lime, are friable, and take water freely. A substratum of gravelly coarse sandy loam limits the water-holding capacity of this soil.

Included with this soil in mapping are small areas of Gravelly land and of Parshall fine sandy loam, level.

Corn and small grains make fair to good yields on this Manning soil. Essential to maintaining good yields are use of a cropping system in which row crops are grown only every other year, drilling applications of fertilizer, and leaving crop residue standing in the field between growing seasons. Wind stripcropping is another good practice that reduces the hazard of erosion. This soil is fair for trees. (Capability unit IIIes-3, Sandy range site)

Manning fine sandy loam, gently sloping (3 to 6 percent slopes) (McB).—This soil is in small, scattered areas on the side slopes of high gravelly terraces. It is mainly along the Heart River and Antelope Creek. In places moderate erosion has occurred.

The surface layer is generally very dark grayish-brown fine sandy loam or loam about 4 inches thick. In the moderately eroded areas, however, the color of the surface layer is dark grayish brown. The subsoil is dark grayish-brown, noncalcareous loam about 17 inches thick. The lower part contains scattered stones and pebbles.

Included with this soil in mapping are small areas of Manning loam, level, and Gravelly land. The included areas make up 5 to 20 percent of the acreage in this mapping unit.

Most of the acreage is cultivated, and fair to good yields of corn and small grains are obtained. Use of a cropping

system in which row crops are grown only every other year, application of a suitable fertilizer at seeding time, and good management of crop residue are important in maintaining fertility and controlling wind erosion. Droughtiness is a serious limitation. This soil is fair for trees. (Capability unit IIIes-3, Sandy range site)

Manning fine sandy loam, sloping (6 to 9 percent slopes) (McC).—This soil contains larger areas of Gravelly land than Manning fine sandy loam, gently sloping. In some places the included areas make up 10 to 30 percent of the acreage in the mapping unit. This Manning soil is fair for trees. (Capability unit IIIes-3, Sandy range site)

Midway Series

In the Midway series are soils that are shallow over clay loam shale. These soils are sloping to steep and occur in the uplands.

The surface layer is dark grayish-brown, friable, weakly to strongly calcareous clay loam about 4 inches thick. It has weak, medium, blocky to weak, fine, crumb structure.

The surface layer rests on slightly weathered, dark-gray, calcareous, stratified soft shale. This underlying shaly material is massive or has platy structure, and it contains only a few roots. Pockets and nests of salt crystals are common in the upper part and in the lower strata.

The texture of the surface layer ranges from heavy clay loam to silty clay, and the thickness of the layer ranges from 2 to 6 inches. The color of the underlying shaly material ranges from light yellowish brown to dark olive, and the texture ranges from heavy clay loam to clay.

These soils take in water slowly and have excessive surface drainage. They are low in fertility and are subject to severe water erosion.

The Midway soils occur with the Moreau and Regent soils, but unlike those soils, they lack a distinct subsoil. Their surface layer and substratum are finer textured than those of the Bainville soils.

Most areas of these Midway soils are in native grass and are used for grazing. The shallow profile, low fertility, and steep slopes make these soils unsuitable for cultivated crops. In Stark County the Midway soils are mapped only in undifferentiated units with the Bainville and Moreau soils and with Rock outcrop.

Mine Dumps

Mine dumps (Md) consists of coal pits and their associated piles of waste. Some of the areas are still mined, but others have been abandoned for years. Some of the pits are open and have steep, irregular slopes that have a gradient of 100 percent. In some places the piles of waste consist of raw shale and sandstone. Included in this unit are cave-in areas of abandoned underground mines near South Heart and Dickinson. In these areas there are sinkholes where the roof of the mine has caved into the abandoned shafts and tunnels. Between the holes, the surface is undisturbed and small patches of the upland soils remain.

The total acreage of this land type is small, and the areas are used for limited grazing or are idle. It is questionable whether most of the areas can be reclaimed for better grazing. In time, however, the native vegetation will cover and heal much of this bare land. This land type is not suitable for trees. (Capability unit VIIIs-1, not placed in a range site)

Moreau Series

The Moreau series consists of moderately deep, clayey soils that are nearly level to strongly sloping. These soils are underlain by shale. They occur in scattered areas in the uplands, intermixed with areas of other soils. Large areas of these soils are south of Belfield and west of Schefield. Smaller areas occur in several other parts of the county.

The surface layer is dark grayish-brown silty clay that is weakly calcareous in most places and is about 4 inches thick. This layer has a granular or platy structure and is likely to have a thin crust when dry. Cracks that are as much as half an inch wide and that extend into the subsoil are common late in summer and in fall.

The subsoil is dark grayish-brown, very firm and dense silty clay about 16 inches thick. In places its color is as dark as that of the surface layer. The subsoil has weak, coarse, prismatic and blocky structure and is calcareous in the upper part and strongly calcareous in the lower part. A few pockets of gypsum and other salts are common in the lower part and extend downward into the underlying material.

The underlying material is olive-gray or gray clay shale that is very limy and contains salts that restrict the growth of roots. Most of this layer is massive, but when the material is disturbed, large, irregular pieces of shale break into thin layers or plates. This layer contains few roots.

The surface layer ranges from 2 to 6 inches in thickness, and the texture is silty clay loam or clay in some places. In many spots or patches the surface layer is more crusted than that in the profile described in the preceding paragraphs, and the platy structure is more pronounced in those areas. The texture of the subsoil ranges from clay to silty clay loam, and the thickness of that layer ranges from 8 to 24 inches. The places where the subsoil is thinnest are in the areas where the slopes are steep or where salts are concentrated in the subsoil and substratum.

These soils have good surface drainage but slow internal drainage. There is a large amount of runoff, and water erosion and wind erosion are hazards when the surface is not protected by a cover of plants.

The Moreau soils occur with the Promise and Regent soils, but they have a thinner surface layer and subsoil than those soils and they contain more lime. Unlike the Midway soils, they have a distinct subsoil. The Moreau soils are finer textured and deeper than the Bainville soils, and they have a thinner subsoil and contain more clay than the Morton soils.

The Moreau soils are fair for field crops and good for range. A large part of the acreage is cultivated. These soils are more difficult to manage than many of the other soils in the county because of their high content of clay and moderate concentration of salts in their subsoil.

Moreau silty clay, level (0 to 3 percent slopes) (MeA).—This soil is mostly in the southwestern quarter of the

county. The surface layer is mainly friable silty clay that has granular structure and is 3 to 5 inches thick. In some places, however, the structure is platy and a crust forms on the surface when this soil is dry. The crusted spots are nonlimy, and the areas where the structure is granular are calcareous. Some material from the subsoil has been mixed into the surface layer by tillage. The subsoil is clay. It has weak, coarse, prismatic and strong, coarse, blocky structure and is about 16 inches thick. Depth to the soil material that contains enough salts to restrict the growth of plants ranges from 10 to 28 inches. Crusted spots occur where the salts are high in the soil profile.

Included with this soil in mapping are areas of Rhoades loam and Promise silty clay and areas where wind erosion has removed most of the original surface layer. The Rhoades soil occupies from 0 to 10 percent of the acreage mapped as this soil, and the Promise soil occupies 5 to 15 percent.

This Moreau soil is used mainly for cultivated crops. It is better suited to alternate summer fallow and barley or wheat than to other cropping systems. During the periods when the soil is fallowed, it is important to keep a mulch of crop residue on the surface. Such a mulch increases the intake of water and reduces the hazard of wind erosion. Applying a fertilizer that contains nitrogen and phosphate is profitable in all but the drier growing seasons. This soil is not suitable for trees. (Capability unit IIIse–4, Clayey range site)

Moreau silty clay, gently sloping (3 to 6 percent slopes) (MeB).—This soil has a surface layer of calcareous silty clay mixed with patches of noncalcareous silty clay loam. The silty clay has a granular structure, and the silty clay loam has a platy structure. The subsoil is 8 to 22 inches thick and has a texture of silty clay or clay that has weak prismatic and strong, fine, blocky structure. The lower part contains nests of salt crystals.

Included with this soil in mapping are a few areas of Rhoades clay loam and Promise silty clay.

Runoff is fairly rapid as a result of the slow permeability and long slopes. In places moderate erosion has occurred, and there are numerous rills and small gullies on the slopes.

Approximately 70 percent of the acreage is cultivated, and wheat and barley are the main crops. About the same kind of management is required as that described for Moreau silty clay, level. In addition, contour stripcropping is well suited to this soil. This practice helps to check water erosion. It also helps to hold the water from rain and snow where it falls, and as a result, more water enters the soil. This soil is not suitable for trees. (Capability unit IIIes–4, Clayey range site)

Moreau silty clay, sloping (6 to 9 percent slopes) (MeC).—This soil is on the upper part of long slopes or is on the tops of isolated hills. It is highly susceptible to water erosion. In several places most of the original surface layer has been lost through erosion and the present surface layer is lighter colored than the original one. In these eroded areas, the plow layer includes part of the subsoil.

Included with this soil in mapping are a few small areas of Midway silty clay and Bainville clay loam.

Where this Moreau soil is in fields that are tilled on the contour, it is mainly in odd areas that are seeded to adapted perennial grasses. This soil is well suited to these grasses. Susceptibility to water erosion, poor soil tilth, and low fertility are limitations if cultivated crops are grown continuously. This soil is unsuitable for trees. (Capability unit IIIes–4, Clayey range site)

Moreau stony soils (Mf).—These soils are mainly in the southwestern corner of the county. In most places they have slopes of 4 to 9 percent, and they have numerous pieces of chert and flint, both on the surface and in the surface layer. These stones range from 5 to 20 inches in diameter.

Included with these soils in mapping are small areas of Regent silty clay loam. This included soil also has stones on the surface and in the surface layer.

These Moreau soils are mainly in range. Removing the stones so that cultivated crops can be grown is not practical. Therefore these soils should remain in range and should be grazed according to the amount of forage available. They are not suitable for trees. (Capability unit VIs–Cy, Clayey range site)

Moreau-Midway silty clays, strongly sloping (9 to 15 percent slopes) (MgD).—About 60 to 70 percent of this complex is Moreau silty clay, and 30 to 40 percent is Midway silty clay. The Moreau soil is immediately below the crests of ridges in strongly sloping uplands and on the lower part of the slopes. The Midway soil is on the crests of ridges and on the upper part of the slopes. These soils occur in several scattered areas in the southern half of the county. They occur with undifferentiated units of Bainville and Midway soils.

The Moreau soil has a surface layer of silty clay about 4 inches thick and a subsoil about 16 inches thick. The Midway soil also has a surface layer of silty clay about 4 inches thick. Beneath the surface layer is partly weathered shale. Underlying both of these soils is unweathered olive-gray silty clay and clay shale. Both of these soils are calcareous.

Nearly all of this complex is in grass, and the soils are only slightly eroded. They are better used for range and pasture than for cultivated crops, and they are not suited to trees. Suitable management practices are described briefly in the section "Use of the Soils for Range." (Capability unit VIe–Cy, Clayey range site)

Moreau-Rock outcrop complex (2 to 6 percent slopes) (Mk).—This complex consists of moderately deep and shallow, clayey soils underlain by hard bedrock. The areas are in the uplands southwest of Dickinson. Small areas of the Moreau-Midway-Rock outcrop complex occur with these soils.

The surface layer is generally dark grayish-brown sandy clay loam about 3 inches thick. The subsoil is grayish-brown sandy clay about 8 inches thick. Hard bedrock lies beneath the subsoil in most places. In about 15 percent of the acreage, however, bedrock crops out on the surface. Both the surface layer and subsoil are free of lime.

This complex is suitable only for permanent pasture or range, and about two-thirds of it is in range. The main limitations to growing crops are the low available moisture capacity and susceptibility to erosion. Areas now in crops can easily be seeded to adapted perennial grasses if a press drill is used. The areas are not suited to trees. (Capability unit VIe–Cy, Clayey range site)

Moreau-Midway-Rock outcrop complex (6 to 15 percent slopes) (Mh).—From 30 to 55 percent of this complex is Moreau clay. Another 45 to 65 percent is Midway soils that contain outcrops of bedrock, and about 15 to 40 percent of each area consists of outcrops of bedrock. The slopes are mainly between 6 and 15 percent. Runoff is rapid on these soils, and the hazard of water erosion is severe.

These soils are better suited to grazing than to cultivated crops, and they are mainly in range. Grazing ought to be regulated according to the amount of forage available in different seasons and according to the condition of the range. Grazing early in spring stunts the range plants and causes a gradual decline in the yields of forage. These soils are not suited to trees. (Capability unit VIIs–TB, Thin Breaks range site)

Morton Series

The Morton series consists of deep, well-drained, nearly level to sloping soils of the uplands. These soils developed in material weathered from silty shale.

The surface layer is very dark brown, friable loam, silt loam, or clay loam that is free of lime and is about 6 inches thick. It has crumb or fine subangular blocky structure.

The subsoil is generally very dark grayish-brown, friable clay loam that has distinct prismatic and blocky structure and is about 28 inches thick. Roots easily penetrate this layer. The upper part is noncalcareous, but the lower part contains a large amount of lime in most places. The texture of the surface layer and subsoil is influenced by the texture of the underlying material.

The underlying material is pale-olive or light olive-brown, friable silt loam. It is limy and has blocky and platy structure. The surfaces of the prisms and blocks have a coating of darker colored material.

The surface layer ranges from 2 to 8 inches in thickness and from dark brown to very dark grayish brown in color. The subsoil ranges from dark brown or very dark grayish brown to light brownish gray in color, from loam to silty clay loam in texture, and from 18 to 42 inches in thickness.

These soils have high available moisture capacity, moderate permeability, and high natural fertility. Losses from wind and water erosion are slight to moderate.

The Morton soils occur with the Vebar and Parshall soils, but they developed in material weathered from silty shale instead of in material that has a texture of fine sandy loam. They contain less clay and have a more friable subsoil and underlying material than the Regent soils. The Morton soils are not so dark colored as the Arnegard and Grail soils, and they have a thinner surface layer. Their substratum is not varied like that of the Farland soils, and their profile does not contain layers of dark-colored alluvium.

The Morton soils are used mostly for cultivated crops, mainly wheat, barley, oats, and corn. Yields are moderately high to high.

Morton stony loam (Mm).—This soil is in the higher parts of the uplands south of Dickinson. It lies between North Dakota Highway No. 22 and U.S. Highway No. 85. The slopes range from 3 to 9 percent. Erosion has been slight.

The surface layer is covered with numerous pieces of flint and chert that make tillage impractical. These stones range from 4 to 20 inches in diameter and generally have a blocky shape.

Included in some of the more sloping areas of this soil are areas of Chama and Bainville silt loams. These included soils make up from 10 to 15 percent of the acreage of this mapping unit.

Removing the stones from this Morton soil is not practical. Pasture or range is the best use, and all of the acreage is now in range. This soil is not suitable for trees. (Capability unit VIs–Si, Silty range site)

Morton-Bainville complex, strongly sloping (9 to 15 percent slopes) (MnD).—This complex of soils is mainly on the sides of low hills and ridges that are scattered throughout areas of less sloping uplands. From 40 to 55 percent of the complex is Morton silt loam on the lower part of the slopes; 15 to 30 percent is Bainville loam or silt loam on the ridgetops and upper part of the slopes; and 20 to 30 percent is Chama silt loam on the middle part of the slopes. Runoff is excessive, and these soils are slightly to moderately eroded.

The Morton soil has a surface layer of very dark grayish-brown, noncalcareous silt loam about 5 inches thick. Its subsoil is about 20 inches thick and is free of lime in the upper part. The Bainville and Chama soils have a surface layer of dark grayish-brown, calcareous silt loam about 4 inches thick. The Bainville soil lacks a subsoil, but the Chama soil has a subsoil that is calcareous, has weak prismatic and blocky structure, and is about 6 inches thick.

About half of this complex is cultivated, and the rest is in range. In the areas that are cultivated, grass should be grown for a large part of the time in the cropping system, or the areas should be seeded to perennial grasses and used for hay or pasture. Only when these soils are kept in permanent sod is erosion kept to an allowable rate. These soils are not suitable for trees. (Capability unit IVe–4L, Silty range site)

Morton-Chama clay loams, sloping (6 to 9 percent slopes) (MoC).—The soils of this complex occur in several scattered areas in the sloping to steep uplands. The soils generally occur together on the same single slope. The Morton soil is on the lower part of the slope, and the Chama soil is on the upper part. Where these soils have been cultivated, they are moderately eroded by wind and water.

The surface layer of the Morton soil is clay loam about 4 inches thick. This soil has a dark grayish-brown subsoil that is about 20 inches thick. The subsoil has distinct prismatic and blocky structure and contains lime at a depth of 14 to 20 inches. The Chama soils have a loam surface layer that contains lime and is lighter colored than that of the Morton soils. Their surface layer is also about 4 inches thick, and their subsoil is 8 to 19 inches thick. Their subsoil is grayish brown and has weak, prismatic structure. Both the Morton and Chama soils are underlain by light-gray to pale-olive, friable, stratified silt loam or clay loam shale.

Included with these soils in mapping are a few small areas of Bainville loam. The Bainville soil is on the crests of ridges or on the extreme upper part of the slopes.

The soils of this complex are fair to good for crops, and they are suited to corn and to all the commonly grown

small grains. Water erosion is a hazard on the lower part of the slopes, and wind erosion is a serious hazard on the ridge crests and upper part of the slopes. Protection should be provided by leaving stubble and crop residue on the surface for as much of the time as feasible. Contour stripcropping, terraces, and diversions are also needed in many places. These soils are fair for trees. (Capability unit IIIe–6, Silty range site)

Morton-Chama silt loams, sloping (6 to 9 percent slopes) (MpC).—This complex consists of Morton and Chama silt loams on the side slopes of low hills in the uplands. These soils occur together on the same slope, but the Morton soil occupies the lower half of the slope and the Chama soil occupies the upper part. The complex occurs in many places in the county, but it is mainly in the area south of Interstate Highway 94 and east of the village of Lefor. In areas that have been cultivated, these soils are slightly eroded.

The Morton soil has a surface layer of silt loam about 5 inches thick and a well-defined subsoil of dark grayish-brown clay loam that has distinct prismatic structure and is about 22 inches thick. Lime is at a depth of 15 to 22 inches. The Chama soil has a surface layer that is about 4 inches thick and is lighter colored than that of the Morton soil. Its subsoil is 8 to 19 inches thick. The Chama soil is limy to the surface. Both the Morton and Chama soils are underlain by light-gray to pale-olive, friable, stratified silt loam and weak clay loam shale.

Included with these soils in mapping are a few small areas of Bainville loam. The Bainville soil is on the crests of the slopes.

Approximately 65 percent of the acreage of this complex is cultivated, and medium to moderately high yields are obtained. Intensive practices are needed that will protect these soils from erosion and maintain productivity. These soils are fair for trees. (Capability unit IIIe–6, Silty range site)

Morton-Chama silt loams, sloping, eroded (6 to 9 percent slopes) (MpC2).—This complex is similar to Morton-Chama silt loams, sloping, but it is eroded to varying degrees. The surface layer is only 2 to 5 inches thick. These soils are susceptible to further erosion by wind and water.

Nearly all of the acreage is cultivated. Where these soils are cultivated, grass should be included for long periods in the cropping system and special fertilization is required. Small grains make fair yields on these soils. Growing small grains and pasture crops alternately provides the safest and most intensive use of these soils that will still keep soil losses within allowable limits. These soils are fair for trees. (Capability unit IVe–4L, Silty range site)

Morton and Farland clay loams, level (0 to 3 percent slopes) (MrA).—The largest areas of this undifferentiated unit are in the south-central part of the county near Schefield in township 137 N., ranges 96 and 97 W. Runoff is medium, and these soils are slightly eroded.

The Morton and Farland soils have similar profiles, but the Morton soils developed in material weathered from soft shale, and the Farland soils developed in stratified loamy alluvium. Generally, the surface layer is very dark grayish-brown, friable clay loam about 6 inches thick. It is separated from the subsoil of dark grayish-brown clay loam by an abrupt boundary. The subsoil is about 22 inches thick. The lower part is very limy and contains many nodules and spots of white lime. Pieces of flint or chert, 2 to 16 inches in diameter, are common in the soil profile, but they are not numerous enough to hinder tillage.

Included with these soils in mapping are small areas of Regent silty clay loam and Morton silt loam. These included soils make up as much as 15 percent of the acreage of this mapping unit.

The soils of this unit are easily worked and are highly productive. They are suited to all the crops commonly grown in the county. The hazard of water erosion is slight. These soils are moderately resistant to wind erosion.

These soils are used mainly for cultivated crops. A suitable cropping system is one in which corn or summer fallow is followed by small grains grown for 1 or 2 years. Where these soils are in large fields, moderate protection should be provided from wind erosion. Crop residue left on the surface protects the soils, or pattern-type windbreaks can be used for protection. These soils are good for trees. (Capability unit IIc–6, Silty range site)

Morton and Farland clay loams, gently sloping (3 to 6 percent slopes) (MrB).—The soils of this undifferentiated unit are on slopes of medium length or on long slopes in the uplands in the south-central part of the county. In some places they have lost from 25 to 75 percent of their original surface layer through water erosion.

In areas that have not been eroded, the present surface layer is about 5 inches thick. In moderately eroded areas, it is 2 to 4 inches thick and the upper part of the subsoil has been mixed into it by tillage. The lighter colored areas in some fields are generally indicative of eroded areas. The subsoil of the Morton soil is dark grayish-brown to olive-gray, friable clay loam about 30 inches thick. It has an abundant supply of lime in the lower part. The subsoil of the Farland soil is a dark-gray silt loam that grades through dark grayish-brown silty clay loam to olive-gray silty clay loam.

Included with these soils in mapping are a few small areas of Grail silty clay loam, level. Also included are small areas of Regent silty clay loam, gently sloping.

The soils of this undifferentiated unit are good for crops, and about three-fourths of the acreage is cultivated. In areas that are cultivated, contour stripcropping or field stripcropping and good management of crop residue are needed to protect the soils from water erosion. Grassed waterways should be established in the intermittent drainageways, and terraces are desirable in many of the fields where the slopes are long. These soils are good for trees. (Capability unit IIIe–6, Silty range site)

Morton and Farland silt loams, level (0 to 3 percent slopes) (MsA).—The soils of this undifferentiated unit occur in large areas in some of the higher uplands, but the areas generally are between 10 and 40 acres in size. Although these soils are mostly nearly level, the slopes are adequate for good drainage. These soils take in moisture well and are only slightly eroded.

The profiles of these soils are similar. The surface layer is very dark grayish-brown silt loam that is about 6 inches thick and is separated from the subsoil by an abrupt boundary. The subsoil has a texture of clay loam and is about 24 inches thick. Its lower part is calcareous and contains many nodules and spots of white lime.

Included in several areas of these soils in mapping are areas of Grail silty clay loam and Arnegard loam, level. These included soils make up 5 to 20 percent of the acreage of this mapping unit.

The soils of this unit are easily worked, are highly productive, and are suited to all the crops commonly grown in the county. They are resistant to wind erosion and only slightly susceptible to water erosion. Generally, applications of fertilizer give good returns on these soils. The semiarid climate with its variable amount of rainfall is the main cause of limited yields in some years. These soils are good for trees. (Capability unit IIc-6, Silty range site)

Morton and Farland silt loams, gently sloping (3 to 6 percent slopes) (MsB).—This undifferentiated unit is the largest of the mapping units and occurs in most parts of the county. In about 20 percent of the acreage, these soils are moderately eroded.

The profiles of these Morton and Farland soils are similar. The surface layer is very dark brown loam or silt loam that is about 6 inches thick in areas that are not eroded, and it is 3 to 4 inches thick in areas that are eroded. The subsoil is very dark grayish-brown clay loam about 17 to 28 inches thick. It has moderate prismatic and blocky structure and has lime in the lower part. The subsoil is easily penetrated by roots.

Included with these soils in mapping are small areas of Grail silty clay loam, level, and Chama loam, sloping.

Most of the acreage is cultivated. The soils are suited to small grains, corn, and tame grasses, but they are moderately susceptible to erosion by wind and water. Where these soils are cultivated, a combination of one or more practices that control erosion should be used. These practices are contour stripcropping or wind stripcropping and use of grassed waterways, terraces, and stubble-mulch tillage in fallowed areas. Applying commercial fertilizer is generally profitable. The amount of fertilizer needed should be determined by testing the soils periodically. These soils are good for trees. (Capability unit IIIe-6, Silty range site)

Morton-Rhoades loams, level (0 to 3 percent slopes) (MtA).—This complex consists of deep, friable Morton loam; shallow Rhoades loam that has a crusted surface layer and a pan layer in the subsoil; and deep, friable Belfield loam. The Morton soil occupies 40 to 55 percent of the acreage, the Rhoades soil 20 to 30 percent, and the Belfield soil 15 to 20 percent. These soils occur in an irregular pattern that is repeated every 20 to 100 feet. They are only slightly eroded.

Areas of this complex in native grass have microrelief consisting of a nearly level plain speckled with small depressions, or pits. The Rhoades soil, in and adjacent to the depressions, is scabby and has a sparse cover of grass. The difference in elevation between the low and high areas ranges from 3 to 8 inches. The cultivated areas do not have this pitted topography, because tillage has filled the depressions and leveled the surface. In areas that are cultivated, a thick crust forms in the areas that were formerly scabby and pitted, and those areas have a grayish color.

The Morton soil has a dark-colored, friable surface layer, about 6 inches thick, and a well-developed subsoil that is easily penetrated by roots. The subsoil has prismatic and blocky structure and is about 24 inches thick. The Rhoades soil occurs in and adjacent to the depressions and scabby spots. It has a thin, crusted surface layer of grayish-brown loam. Its subsoil is dense silty clay that has columnar or prismatic structure. This subsoil is 10 to 25 inches thick and has abundant lime and salts in the lower part. The Belfield soil has a surface layer and subsoil similar to those of the Morton soil, except that the lower part of the surface layer has a grayish color. Also, the Belfield soil has a salty substratum.

Yields of crops grown on the soils of this complex are reduced by the poor soil tilth and high content of salts in the Rhoades soil. A 2-year rotation of alternate summer fallow and small grains is best suited to these soils. Commercial fertilizer should be applied according to the needs in each field and the needs of the crop to be grown. Runoff can be reduced and wind and water erosion can be controlled by stubble mulching when the soils are summer fallowed and practicing field stripcropping across the general slope. These soils are not suitable for trees. (Capability unit IIIs-5P, Silty range site)

Morton-Rhoades loams, gently sloping (3 to 6 percent slopes) (MtB).—Runoff is a serious hazard on these soils. Grassed waterways are needed in many of the drainageways that dissect the areas. The grassed waterways are practical where contour stripcropping is practiced.

Small grains grown on these soils make fair to good yields. The soils are not suitable for trees. (Capability unit IIIe-6P, Silty range site)

Morton-Rhoades loams, sloping (6 to 9 percent slopes) (MtC).—This complex consists mainly of Morton and Rhoades loams that have been kept in native grass and are only slightly eroded. It also includes areas of Belfield loam and of Chama silt loam. About 50 to 65 percent of the acreage is Morton and Belfield loams, 10 to 15 percent is Rhoades loam, and 15 to 25 percent is Chama silt loam.

The soils are on long slopes in the uplands. The lower two-thirds of the slope is occupied by Morton, Belfield, and Rhoades soils in an irregular pattern, and the upper part, on or near the crest, is occupied by the Chama soil. Areas of the Rhoades soil are most prominent near the base of the slopes, and they are bare or are sparsely covered by grass. Areas of this complex contain scattered scabby spots that have a pitted microrelief. The soils are not suited to trees. (Capability unit IIIe-6P, Silty range site)

Morton-Rhoades loams, sloping, eroded (6 to 9 percent slopes) (MtC2).—In this complex are the same kinds of soils as those in Morton-Rhoades loams, sloping, except that the areas are more eroded. Water erosion has removed from 50 to 75 percent of the surface layer on the upper part of the slopes and along intermittent drainageways.

Nearly all of this complex is in small, scattered areas in cultivated fields. Yields of the commonly grown cultivated crops range from fair to poor. These soils can best be managed by growing grass for hay or pasture for a period of 3 to 10 years and then growing tilled crops for an equal number of years. The soils are not suited to trees. (Capability unit IVe-4P, Silty range site)

Parshall Series

In the Parshall series are deep, well-drained, nearly level to gently sloping soils developed in moderately sandy alluvium and in moderately sandy material from

the uplands. These soils occur in all parts of the county.

The surface layer is very dark brown fine sandy loam that is free of lime. It has fine blocky structure or is single grained and is about 12 inches thick.

The subsoil is very dark grayish-brown fine sandy loam about 30 inches thick. It has weak prismatic structure. The upper part is free of lime, but the lower part is calcareous.

The substratum is dark grayish-brown, very friable fine sandy loam that contains lime in places. This layer is single grained or has weak blocky structure.

The surface layer is dark grayish brown in places and ranges from 8 to 18 inches in thickness. The subsoil ranges from 15 to 30 inches in thickness and has a texture of sandy loam in some places. The color of the subsoil ranges from very dark grayish brown to grayish brown. The subsoil has prismatic structure, but the structure breaks to blocky.

These soils have moderately rapid internal drainage. They have high natural fertility but are easily eroded by wind.

The Parshall soils have a darker colored, thicker surface layer and subsoil than the Vebar soils, and they are darker colored and less sandy than the Lihen soils. Their surface layer and their subsoil contain less clay than do those of the Manning soils, and they lack the gravelly substratum that is typical of the Manning soils. The surface layer and subsoil of the Parshall soils are fine sandy loam instead of loam like those of the Arnegard soils.

Approximately three-fourths of the acreage is cultivated, and good yields of small grains, corn, and tame grasses are obtained. The Parshall soils are well suited to irrigation if adequate water is available.

Parshall fine sandy loam, level (0 to 3 percent slopes) (PaA).—This is the only Parshall soil mapped separately in this county. It is mainly in nearly level areas of the uplands, but the areas are slightly undulating in some places. In most places the height of the rises is no greater than 3 feet from the lowest point to the top. Erosion has been slight in most areas, but it has been moderate in a few scattered areas.

In areas that are only slightly eroded, the surface layer is very dark brown fine sandy loam about 11 inches thick. In the moderately eroded areas, it is 3 to 7 inches thick. The surface layer is underlain by a subsoil of dark-brown or very dark grayish-brown fine sandy loam that is about 30 inches thick and has prismatic structure. The substratum contains layers both of fine sandy loam and loamy fine sand, and it is slightly limy in some places.

Included in some areas of this soil in mapping are areas of Vebar fine sandy loam and Lihen loamy fine sand. In places the Vebar soil makes up 10 to 30 percent of the acreage in an area and the Lihen soil makes up 5 to 15 percent.

This Parshall soil is highly productive and is suited to all the crops commonly grown in the county. Susceptibility to wind erosion is the main limitation, but this erosion can be controlled by practicing wind stripcropping and keeping a mulch of crop residue on the surface. This soil is good for trees, and field windbreaks grow well on it. Windbreaks can be used instead of wind stripcropping to protect this soil. (Capability unit IIIe-3, Sandy range site)

Promise Series

The Promise series consists of deep, moderately well drained soils in nearly level and gently sloping upland swales and on valley terraces. These soils developed in clayey sediments deposited by water or in material weathered from shale.

The surface layer is very dark grayish-brown, friable silty clay that is noncalcareous and about 3 inches thick. This layer has moderate, fine, blocky or granular structure. Mixed with the areas where the surface layer has granular structure are a few patches where there is a thin surface crust. The subsoil is dark olive-gray clay that is about 18 inches thick. It has moderate, coarse, prismatic and strong, fine, blocky structure. The upper half is noncalcareous; the lower half is limy, and the content of lime increases with increasing depth. In the areas that have a crust, the subsoil contains salt crystals that are close to the surface.

The substratum is olive-gray to pale-olive silty clay that has blocky structure. It is limy (fig. 9) and contains small pockets of salt crystals. A few roots have penetrated the substratum.

The surface layer ranges from dark grayish brown to very dark grayish brown in color and from 2 to 4 inches in thickness. In cultivated areas part of the subsoil has been mixed into the surface layer. The color of the subsoil ranges from very dark gray to dark olive gray, and the thickness ranges from 16 to 25 inches. The texture of the subsoil is silty clay in some places. In places the lower part is very strongly calcareous. The structure of the subsoil is distinctly prismatic in some places and only weakly prismatic in others, but fine and medium blocks are distinct in all the layers. In places the subsoil and substratum contain the surface layer of an old buried soil, and this buried layer is as dark colored as the present surface layer.

These soils have good moisture-holding capacity and moderately high natural fertility. They are moderately susceptible to wind erosion and slightly susceptible to water erosion.

The Promise soils have a thicker subsoil than the Moreau soils. They developed in alluvium and in local water-transported hillside sediments, instead of in bedded shaly material. They are finer textured than the Regent and Savage soils.

About 80 percent of the acreage of Promise soils is cultivated. Good yields of small grains, tame grasses, and native grasses are obtained.

Promise silty clay, level (0 to 3 percent slopes) (PrA).—This soil is in the northeastern part of the county on nearly level, broad terraces along the valley of the Little Knife River. It also occurs southwest of Dickinson. Most of the areas are small and adjoin areas of Savage, Rhoades, and Regent soils.

The surface layer is very dark grayish-brown silty clay about 4 inches thick. It has granular structure and has a surface crust in small, scattered spots. The subsoil is dark olive-gray clay 16 to 24 inches thick. Where there is a surface crust, the subsoil is thinner and contains more soluble salts than normal.

Included with this soil in mapping are areas of Rhoades loam. This included soil makes up 5 to 10 percent of the acreage of the mapping unit.

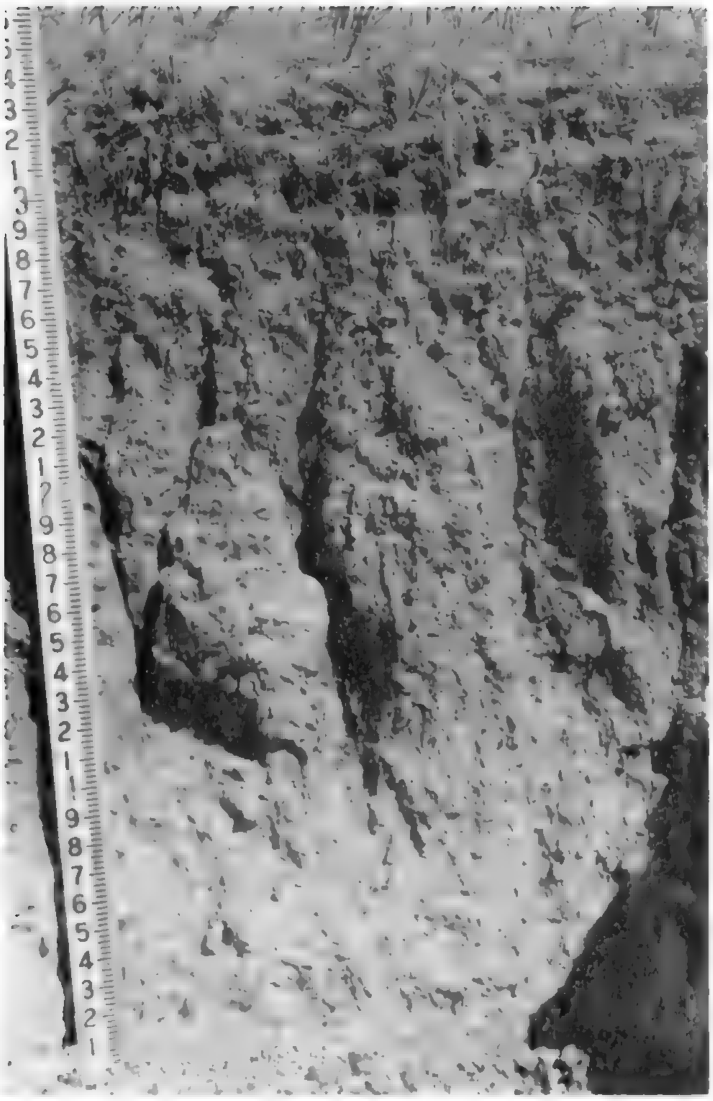

Figure 9.—**Profile of Promise silty clay. The light-colored material in the substratum is lime.**

Runoff is slow, and this Promise soil is only slightly eroded. Wind erosion is the main hazard.

Alternating 1 year of wheat, barley, or oats with 1 year of fallow is a suitable cropping sequence on this soil. When this soil is left fallow, it should be protected from wind erosion by practicing wind stripcropping and leaving crop residue on the surface. This soil is fair for trees. (Capability unit IIe–4, Clayey range site)

Promise silty clay, gently sloping (3 to 6 percent slopes) (PrB).—This soil is on long, gentle foot slopes and in swales that lead from the higher parts of the uplands into the nearly level valleys. It is mainly in small, scattered areas in the eastern one-fourth of the county. This soil is more susceptible to water erosion than Promise silty clay, level. In places erosion has cut small rills not more than 10 to 12 inches deep.

Included with this soil in mapping are areas of Rhoades loam. This included soil makes up 5 to 10 percent of the acreage of the mapping unit.

About 60 percent of the acreage of this Promise soil is cultivated. Contour stripcropping is more suitable for this soil than wind stripcropping. A suitable cropping system is 1 year of wheat or barley followed by 1 year of summer fallow. Runoff and erosion should be controlled, and a fertilizer that contains phosphate and nitrogen ought to be applied. This soil is fair for trees. (Capability unit IIIe–4, Clayey range site)

Regent Series

In the Regent series are deep, well-drained soils that are moderately fine textured. These soils are nearly level to sloping and are in the uplands. Some areas have been moderately eroded by wind or water.

The surface layer is very dark grayish-brown, friable, noncalcareous silty clay loam about 8 inches thick. It has weak, fine, blocky and granular structure.

The subsoil is dark grayish-brown, firm silty clay about 20 inches thick. It has weak, coarse, prismatic and strong, medium, blocky structure (fig. 10). The upper half is generally noncalcareous, but the lower part contains spots and threads of lime. Thin films of darker colored clay and organic matter cover the surfaces of the prisms and blocks.

Figure 10.—**Soil material taken from an area of Regent silty clay loam. This material shows the coarse prismatic and medium or strong blocky structure.**

The underlying material is a soft shale of silty clay or silty clay loam texture that has platy and blocky structure. The upper part contains lime. Gypsum and sodium salts occur in some places.

The surface layer ranges from 4 to 10 inches in thickness and from silty clay loam to clay loam in texture. In places the color of the surface layer is dark grayish brown. The subsoil ranges from 15 to 30 inches in thickness, from dark grayish brown to olive gray in color, and from silty clay loam to light silty clay in texture. The content of lime in the subsoil is variable. In some places all of the subsoil is limy and the content of lime increases with increasing depth. In other places only the lower part is limy.

These soils have slow internal drainage and high available moisture capacity. They are susceptible to both wind and water erosion.

The Regent soils have a thinner, lighter colored surface layer and subsoil than the Grail soils and are finer textured and have a more blocky structure than the Morton soils. They have a thicker surface layer and subsoil than the Moreau soils, and they also have lime at a greater depth. The Regent soils have a thicker surface layer and contain less clay than the Promise soils.

The Regent soils are well suited to small grains, and most of the acreage is cultivated. In fields where this soil is not protected, it is subject to drifting when the velocity of the wind is high. During brief, intense showers, sloping areas that are fallowed are eroded by runoff.

Regent silty clay loam, level (0 to 3 percent slopes) (ReA).—This soil is well drained. It is on the uplands and is widely distributed throughout the county. In a few places it has been moderately eroded by wind.

The surface layer is very dark grayish-brown silty clay loam about 8 inches thick. It has granular structure and is free of lime. The subsoil is dark olive-gray or olive-brown light silty clay about 24 inches thick. It has weak prismatic and strong blocky structure. Lime is at a depth of 13 to 22 inches.

Included with this soil in mapping are areas of Grail silty clay loam, level, and Morton clay loam. The Grail soil makes up 5 to 15 percent of the acreage in the mapping unit, and the Morton soil makes up 10 to 15 percent.

Most of this soil is cultivated and the crops are mainly wheat, barley, and oats. A cropping system that has proven satisfactory is 1 year of barley or wheat followed by 1 year of summer fallow. During the periods of summer fallow, a mulch of trashy material or crop residue should be kept on the surface. The mulch increases the intake of water and helps to control wind erosion. Applying a fertilizer that contains nitrogen and phosphate is a good practice. This soil is fair for trees. (Capability unit IIe–4, Clayey range site)

Regent silty clay loam, gently sloping (3 to 6 percent slopes) (ReB).—This soil is more susceptible to water erosion than Regent silty clay loam, level. About 25 percent of the acreage is already eroded, and sheet and gully erosion are evident in some fields. In the moderately eroded areas, water erosion has removed 2 to 3 inches of the original surface layer, and part of the subsoil is mixed with the surface layer each time the soil is tilled.

In many of the drainageways that cross these soils, grassed waterways should be established. Contour stripcropping or tilling across the slope is important, for these practices slow down runoff and allow more moisture to enter the soil. This soil is fair for trees. (Capability unit IIIe–4, Clayey range site)

Regent-Moreau silty clay loams, level (0 to 3 percent slopes) (RgA).—In this complex are deep Regent silty clay loam, moderately deep Moreau silty clay loam, and shallow Rhoades loam or clay loam that contains a claypan. These soils are so intermixed in an irregular pattern that it was not practical to separate them on the map. The Regent soil makes up 30 to 45 percent of the complex, the Moreau soil makes up 25 to 40 percent, and the Rhoades soil makes up 20 to 30 percent. These soils occur in many parts of the county. They are only slightly eroded.

Where these soils are in native grass, they contain panspot areas of pitted microrelief. The pits, or depressions, are shallow and are filled and leveled when these soils are tilled. Even after the soils are leveled, the panspot areas can be identified, however, as they appear as grayish, crusted spots in cultivated fields. The Rhoades soils occur in and adjacent to the panspot areas and have a more grayish color than the surrounding Regent and Moreau soils. A profile typical of the Moreau soil is described under the Moreau series.

Included in some areas of this soil in mapping are small areas of Belfield silty clay loam.

Most of this complex is used for cultivated crops. Yields are fair to good on the Regent and Moreau soils, but they are poor on the Rhoades soils. In years when less than the normal amount of rainfall is received, yields are reduced more on the soils of this complex than on better soils. Any management practice that increases the content of moisture in the soils is especially important. This is because salts have a less adverse effect on a growing crop when the soil holds a good supply of moisture than when it is nearly dry. These soils are not suited to trees. (Capability unit IIIse–4, Clayey range site)

Regent-Moreau silty clay loams, gently sloping (3 to 6 percent slopes) (RgB).—About 30 to 45 percent of this complex is Regent silty clay loam, 25 to 40 percent is Moreau silty clay loam, and 20 to 30 percent is Rhoades loam or clay loam. Also included in some of the areas are small areas of Belfield silty clay loam. The slopes on which these soils occur are long and smooth and are dissected by intermittent drainageways. Runoff is moderately rapid. These soils are moderately eroded in about one-fourth of the acreage that has been cultivated. In the rest of the acreage, they are only slightly eroded.

About 60 percent of this complex is cultivated, and yields of the commonly grown small grains are fair to good. Susceptibility to water erosion, the content of salts in the subsoil, and the poor soil tilth are all limitations. Special applications of fertilizer are needed, as well as practices that control erosion. These soils are not suited to trees. (Capability unit IIIes–4, Clayey range site)

Regent-Moreau silty clay loams, sloping (6 to 9 percent slopes) (RgC).—About 20 to 30 percent of this complex is Regent silty clay loam, 35 to 50 percent is Moreau silty clay loam, and 15 to 30 percent is Rhoades loam or clay loam. The soils have smooth slopes that are dissected by intermittent drainageways. Runoff is rapid.

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Where these soils are in range, they contain shallow depressions or basinlike panspots and have pitted microrelief. In cultivated fields the former depressions have been filled and leveled by tillage and appear as gray crusted areas. These crusted areas range from 3 to 15 feet in diameter. The Rhoades soils occur in and adjacent to the panspots and are surrounded by the Regent and Moreau soils. The pattern of Rhoades soils, surrounded by Regent and Moreau soils, is repeated many times in each area of this complex.

About 30 percent of the acreage in this complex is cultivated, and the soils are moderately eroded in those areas. Fields of these soils where small grains are grown have a spotty appearance, and yields are reduced in areas where the Rhoades soils occur. The areas in native grass are only slightly eroded and produce good yields of forage. Contour stripcropping and stubble mulching of areas that are fallowed are important practices in managing these soils. Tame grasses should be included in the cropping system to improve the soil tilth and intake of water. These soils are not suited to trees. (Capability unit IVe-4P, Clayey range site)

Rhoades Series

In the Rhoades series are shallow panspot soils that are nearly level to sloping. These soils are in the uplands and on stream terraces. They occur in many parts of the county, but the largest acreage is southwest of Dickinson and in the areas drained by the Little Knife River.

The surface layer is very dark gray, noncalcareous, friable loam about 3 inches thick. It has fine blocky or thin platy structure.

The subsoil is dark grayish-brown, hard, dense silty clay loam about 15 inches thick. It has strong columnar structure in the upper part and prismatic and blocky structure in the lower part. In most places the columns and prisms have thin dark grayish-brown clay films on their surfaces. The lower part of the subsoil is limy.

The underlying material is saline and calcareous. It consists of dense and massive clayey shale that contains a large amount of salts. The salts restrict the growth of plants.

The surface layer ranges from 1 to 6 inches in thickness and from very dark gray to light gray in color. In places the texture is clay loam instead of loam. The subsoil ranges from 8 to 27 inches in thickness and from clay loam or silty clay loam to clay. In some places the Rhoades soils have gypsum and sodium salts in the lower part of their subsoil.

These soils are moderately well drained. They take in water very slowly, and a large amount of water runs off. Water erosion is a hazard where these soils are cultivated.

The Rhoades soils occur with the Grail, Morton, Farland, and Regent soils. They are distinguished from these deep, easily worked soils by their thin, dark-gray, loamy surface layer and their dense, hard subsoil. The Rhoades soils have a thinner, lighter colored surface layer than the Belfield soils. Also, they have a hard subsoil that has columnar instead of prismatic and blocky structure, and they have more salty underlying material. The Rhoades soils have a thinner, finer textured surface layer and subsoil than the Beckton soils.

Approximately 30 percent of the acreage of these soils is cultivated, and barley and wheat are the main crops. Yields are fair to poor, depending on the amount of moisture received during the growing season. Most of the acreage is used for range. Under good range management, fair to good yields are obtained.

Rhoades and Belfield soils, level (0 to 3 percent slopes) (RsA).—This undifferentiated unit occurs in many parts of Stark County. The largest area is south and east of the town of Belfield. About 45 to 70 percent of the acreage is Rhoades loam or clay, and 20 to 40 percent is Belfield loam or silty clay loam. Also included are small areas of Morton, Regent, and Grail soils. The intermittent drainageways that provide surface drainage for the soils of this unit are gullied in a few places.

The areas in range have a pitted topography in which there are high areas interspersed with low basinlike areas of panspots. The difference in elevation from the highest point to the lowest spot ranges from 4 to 10 inches. The panspot areas are bare or sparsely covered with grass. Where the soils have been tilled, the pitted microrelief has disappeared, but the panspot areas remain as somewhat circular, gray, crusted patches, 3 to 10 feet in diameter. The Rhoades soils occur in and adjacent to the panspot areas and the Belfield soils are in the higher areas that generally have a cover of grass. A profile considered typical for the Belfield soil is described under the Belfield series.

About 30 percent of the acreage is cultivated, and the rest is used for grazing. The soils are better suited to range or pasture than to cultivated crops, and they are not suited to trees. Yields of cultivated crops are poor. (Capability unit VIs-Ps, Panspot range site)

Rhoades and Belfield soils, gently sloping (3 to 6 percent slopes) (RsB).—This undifferentiated unit contains about the same kind of soils as Rhoades and Belfield soils, level. The main differences are the gentle slopes and more rapid runoff. The soils are used mainly for grazing. They are not suited to trees. (Capability unit VIs-Ps, Panspot range site)

Saline Alluvial Land

Saline alluvial land (1 to 3 percent slopes)(Sa) is a miscellaneous land type that occurs in drainageways and on nearly level terraces. The areas are small and are scattered throughout the county.

The soil material in this land type is salty throughout. Its color to a depth of 2 to 6 inches ranges from white to light gray, and its texture ranges from loam to silty clay. Beneath this material is sandy to clayey material that is single grained or massive and contains a water table. As a result of the upward movement of the water in the water table, salts and lime are deposited on or near the surface.

Rhoades and Grail soils occur with Saline alluvial land. In places they make up as much as 30 percent of an area mapped as this land type.

The cover of native grasses is sparse or patchy on this land type, and cultivated crops that are planted generally fail to emerge. The land should not be tilled, and only grasses that tolerate salt ought to be seeded where a stand of native grasses is not present on adjacent areas.

The land is not suited to trees. (Capability unit VIs–SS, Saline Subirrigated range site)

Savage Series

In the Savage series are deep, moderately well drained soils that have developed in clayey alluvium. These soils are nearly level. They are mainly on terraces adjacent to tributaries of the Knife River in the northeastern part of the county.

The surface layer is very dark gray, noncalcareous silty clay loam about 6 inches thick. The structure of this layer is medium blocky and fine granular.

The upper part of the subsoil is dark grayish-brown, noncalcareous silty clay loam, and the lower part is olive or olive-brown, limy silty clay. The subsoil has weak prismatic and blocky structure and is about 23 inches thick. It has dark-colored clay films on the surfaces of the prisms.

Several limy layers make up the substratum. In some of these layers, the soil material has a texture similar to that of the layers in the solum, but it is lighter colored. In other places there is a wide range of texture and the substratum contains thin bands, or layers, of dark-colored material transported by water.

The surface layer ranges from 4 to 8 inches in thickness and from dark grayish brown to very dark gray in color. In some areas the subsoil contains gypsum salts. The texture of the subsoil ranges from clay loam to silty clay, and the thickness ranges from 18 to 29 inches.

The Savage soils are finer textured than the Farland and Straw soils. They have a thinner and lighter colored surface layer and subsoil than the Grail soils. The Savage soils are coarser textured throughout the profile than the Promise and Moreau soils. They are less well drained than the Regent soils, and their substratum is more variable in texture, color, and consistence than that of the Regent soils.

The Savage soils have high natural fertility. The hazard of wind erosion is moderate, but the hazard of water erosion is slight.

About 85 percent of the acreage is cultivated. Small grains grown on these soils make high yields.

Savage silty clay loam (0 to 3 percent slopes) (Sg).—This soil is mainly on terraces in the valley of the Little Knife River, but a few areas are along the Heart River. About 65 to 80 percent of the acreage is Savage silty clay loam, and the rest consists mainly of small areas of Promise silty clay and Farland silt loam. Most of the areas are large; they range from 20 to 80 acres in size. This soil is only slightly eroded, even though much of it has been cultivated.

The surface layer is very dark gray, noncalcareous silty clay loam about 6 inches thick. It has granular and fine blocky structure and is easily worked. In a few places there are crusted spots where the surface layer has been affected by salts The subsoil is about 26 inches thick. The upper part is noncalcareous, but the lower part is limy and slightly salty. Where the crusted spots occur, both the surface layer and subsoil are thinner than those in areas free of crusting, and the soil material has been more affected by the salts in the saline substratum.

This soil is well suited to small grains. The hazard of wind erosion is moderately severe. This soil should be protected by leaving most of the stubble on or near the surface during the period when the areas are summer fallowed. In places grassed waterways are needed to prevent gullies from forming or to control further erosion in areas where gullies already occur. This soil is fair for trees. (Capability unit IIe–4, Clayey range site)

Savage-Rhoades silty clay loams, level (0 to 3 percent slopes) (ShA).—This complex consists of deep, friable Savage silty clay loam; areas of panspot soils, mainly Rhoades clay loam; and areas of crusted Promise soils. The Savage soil makes up 40 to 55 percent of the acreage, the Rhoades soil 15 to 35 percent, and the Promise soil 15 to 25 percent. These soils occur in an irregular pattern that is repeated every 20 to 100 feet. Where these soils are in range, the areas consist of a moderately well-grassed, nearly level plain speckled with shallow, nearly round pits that are panspots. These pits are 3 to 9 inches deep and have a sparse cover of grass. In them most of the Rhoades soil occurs. Where the soils have been tilled, the pitted microrelief has disappeared, but the scabby or panspot areas can be distinguished by the grayish, crusted surface layer.

The Savage soil has a surface layer of friable silty clay loam about 6 inches thick, and its subsoil is also silty clay loam. The subsoil has prismatic and blocky structure and is about 22 inches thick. Both the Rhoades and Promise soils have a crusted surface layer, about 3 inches thick, and a salty substratum. The main differences between them are in the subsoil. In the Rhoades soil, the subsoil has columnar structure and contains a pan. In the Promise soil, the subsoil is firm, has blocky structure, and contains many pockets of salts.

A suitable cropping system consists of fallowing these soils every other year in summer and growing a small grain the alternate year. Where the small grain is grown, fertilizer should be applied according to the requirements indicated by the results of soil tests. During fallow periods, these soils ought to be protected by a straw mulch on or near the surface. Farming these soils across the slope or on the contour greatly aids in reducing erosion and losses of moisture. These soils are not suited to trees. (Capability unit IIIs-5P, Clayey range site)

Searing Series

The Searing series consists of moderately deep, well-drained, nearly level and gently sloping soils that developed in material weathered from reddish clinkers, called scoria. These soils occur in scattered areas in the uplands. They are mainly in township 140 N., range 98 W.

The surface layer is reddish-brown, friable, noncalcareous silt loam about 5 inches thick. It has crumb structure and contains a few small pieces of red scoria.

The subsoil is reddish-brown loam that is about 14 inches thick and has coarse prismatic and blocky structure. The upper part is nonlimy, but the lower part is very limy. This layer contains pieces of red scoria that increase in number with increasing depth.

The upper part of the substratum is about 6 inches thick and consists of reddish, limy, friable loam mixed with many pieces of scoria. Below this layer is hard, slightly weathered scoria that few roots can penetrate. The material in the lower part of the substratum origi-

nated from silty shale that had been fired or heated by burning underground coalbeds. This accounts for the reddish color and brittleness of the substratum.

Both the surface layer and subsoil range from loam to silt loam in texture. The surface layer ranges from 3 to 8 inches in thickness, and the subsoil ranges from 10 to 24 inches. The color of the baked silty shale in the substratum ranges from reddish yellow to red. In places the material in the substratum is only slightly broken and is similar to bedrock. In other places it consists of platy pieces and is as droughty as coarse gravel.

The Searing soils occur with the Morton soils, but they are not so deep as the Morton soils. Also, they developed in material weathered from hard clinkers instead of in material weathered from silty shale. They developed in the same kind of material as the Wibaux soils, but unlike the Wibaux soils, they have a distinct subsoil. The Searing soils lack the gravelly layers that occur in the Manning soils.

These soils have medium available moisture capacity and are medium in fertility. They are somewhat droughty and have a limited depth to which roots can penetrate.

Most of the acreage is cultivated. Small grains and corn are the main crops.

Searing loam (3 to 6 percent slopes) (Sm).—This is the only Searing soil mapped in this county. It occurs in several small, scattered areas in the northwestern part of the county. This soil can be recognized from a short distance by the reddish-brown color of the surface layer. Also, in small spots, red clinkers are on the surface. From 70 to 80 percent of the acreage is Searing loam or Searing silt loam, 10 to 20 percent is Morton silt loam, and 10 to 15 percent is Wibaux soils. In a minor acreage, the gradient of the slopes is less than 3 percent.

About two-thirds of the acreage is cultivated. In places material from this soil has been removed in mining operations. In many areas the clinkers are used in place of gravel for surfacing private and secondary roads.

Generally, this Searing soil makes up such a small part of each field that special management is not practical. It should be farmed in the same way as the major soils in the field. This soil is not suited to trees. (Capability unit IIIes-5, Silty range site)

Shale Outcrop

Shale outcrop (10 to 50 percent slopes) (Sp) consists mainly of strongly sloping and steep areas where shale and sandstone crop out. Locally, these areas are called badlands. They occur in scattered areas along the Heart River and in township 138 N., ranges 97 and 98 W.

Areas of this land type contain a smaller proportion of Bainville, Midway, and Flasher soils than occur in Shale outcrop-Bainville complex. In less than 15 percent of the acreage has there been any soil development. The areas that lack soil material do not have a cover of grass. The grassed areas are few; grass grows only in small irregular patches in the less sloping areas and on the bottoms of the gullies. Only limited grazing is possible in those areas. Runoff is rapid, and water erosion is severe. This land type is not suited to trees, and it has not been placed in a range site. (Capability unit VIIIs-1)

Shale outcrop-Bainville complex (10 to 50 percent slopes) (So).—This is a complex of outcrops of soft shale and sandstone and of shallow, hilly and steep Bainville, Midway, and Flasher soils. From 30 to 60 percent of the acreage is shale outcrops, and the rest is Bainville, Midway, and Flasher soils. The areas are along the steep edges of valleys of the Heart River and Antelope Creek and in rough, broken places northwest of Schefield. In some areas ledges of sandstone crop out. In others there are abrupt changes in the slopes. The areas range from strongly sloping to steep.

Erosion removes the material weathered from the shale outcrops too fast for a soil to form. Those areas are bare or have only a sparse cover of grass. The Bainville, Midway, and Flasher soils of the complex have a fair to good cover of native grass. Their profiles are like the ones described for their respective series.

The soils of this complex take in water slowly and have rapid runoff. In places there are large gullies, and some of these are actively eroding. This complex requires good range management to protect the present cover of plants from further deterioration. In many places the range can be improved by deferring grazing for a period of 2 or 3 years. Deferring grazing improves the vigor of the plants and allows some natural reseeding. This complex is not suited to trees (Capability unit VIIs-BL, Badlands range site)

Straw Series

In the Straw series are deep, dark-colored, nearly level soils that developed in loamy alluvium. These soils are on low terraces and flood plains along the Heart and Green Rivers.

The surface layer is very dark brown loam that is free of lime and is about 7 inches thick. It has crumb structure in the upper part and prismatic and blocky structure in the lower part. The soil material in the surface layer is easily worked.

The subsoil is very dark grayish-brown or dark grayish-brown, friable silt loam that has prismatic and blocky structure. The lower part of the subsoil is limy.

The substratum contains many thin layers of friable material that was deposited by streams. The soil material in these layers ranges from nonlimy fine sandy loam to limy silt loam. In many places the substratum contains a layer of dark-colored material that is the former surface layer of a buried soil (fig. 11).

These soils are well drained. They have good available moisture capacity and high natural fertility. The hazards of wind erosion and water erosion are moderately low.

The surface layer ranges from 3 to 8 inches in thickness, and its texture is silt loam in places. The subsoil ranges from 15 to 32 inches in thickness, and its texture is loam instead of silt loam in some places. In many areas the upper part of the subsoil is nearly as dark colored as the surface layer. The lower part of the subsoil ranges from slightly calcareous to strongly calcareous.

The Straw soils occur with the Farland soils, but they have weaker structure, lime higher in the profile, and less clay in the subsoil than those soils. They are less limy than the Havre soils, and unlike those soils, they have a distinct subsoil. The Straw soils are coarser tex-

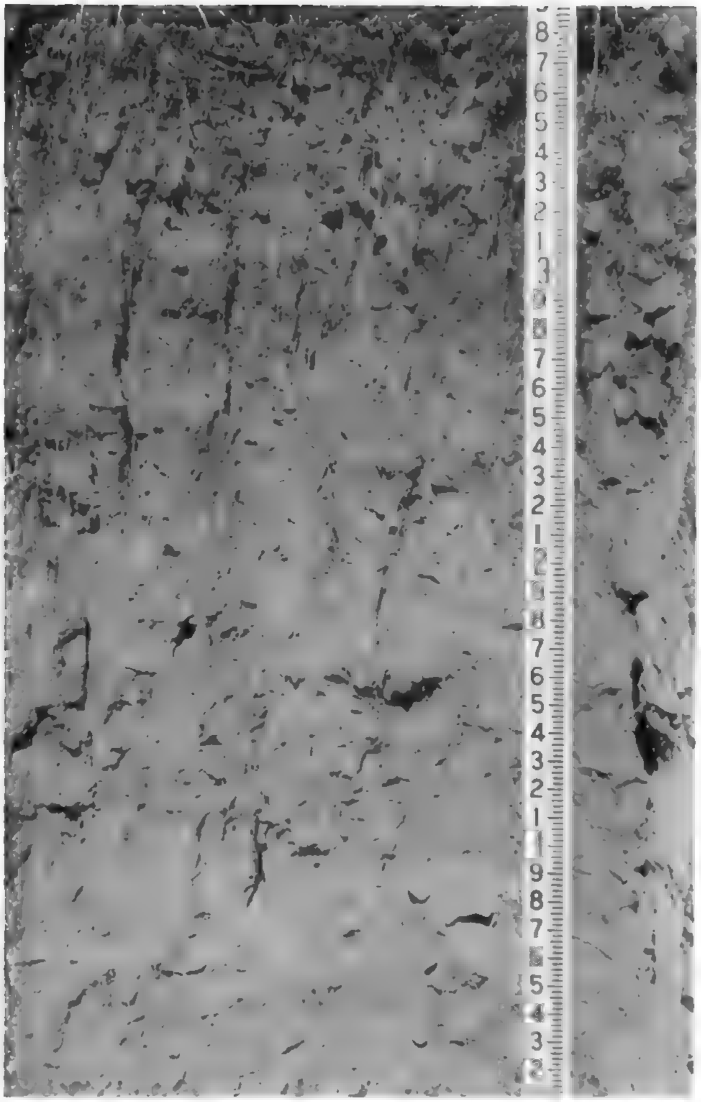

Figure 11.—Profile of Straw loam. This soil contains the dark-colored former surface layer of a buried soil.

tured than the Savage soils, and they are finer textured than the Parshall and Vebar soils.

About 75 percent of the acreage is cultivated. The main crops are small grains, corn, and tame grasses. The nearly level relief and good rate at which water is taken in make these soils well suited to either gravity or sprinkler irrigation.

Straw loam, level (0 to 3 percent slopes) (StA).—This soil is mainly on low terraces and bottom lands along the Heart and Green Rivers. In more than 90 percent of the acreage, the slopes are less than 1 percent. A few areas are undulating, and in those places the slopes range from 2 to 3 percent.

The surface layer is very dark brown, friable loam about 6 inches thick. The subsoil is dark grayish-brown silt loam about 20 inches thick. The lower 8 inches of the subsoil is limy in most places.

Included with this soil in mapping are areas of Farland silt loam and Havre loam. These included soils make up 5 to 15 percent of the acreage in this mapping unit.

This Straw soil is highly productive and is suited to all the crops commonly grown in the county. The hazard of wind erosion is moderately low. Erosion can be easily controlled by leaving crop residue on the surface during the winter months and during periods of summer fallow. Corn can be substituted for summer fallow in the cropping system. This soil is excellent for trees. (Capability unit IIc–6, Silty range site)

Straw and Havre soils, channeled (undifferentiated slopes) (Sv).—The soils of this undifferentiated unit occur in small areas between meandering drainageways and along small stream channels. The channels are steep sided in most places, and they have cut the areas of this unit into small patches. From 30 to 45 percent of the acreage is Straw loam or silt loam, 25 to 35 percent is Havre loam or clay loam, and 15 to 20 percent is Glendive fine sandy loam. Also included are undifferentiated soils in the stream channels. Most of the areas between the channel banks are nearly level. The sides of the channel are sloping to steep, and there are many eroded spots.

The texture of the surface layer ranges from fine sandy loam to clay loam. In many places the surface layer is as dark colored as the one in the profile described for the Straw series. Within short distances, the texture of the surface layer changes from loam to fine sandy loam or silt loam.

In some places these soils have a thick, moderately distinct subsoil. In others they lack a distinct subsoil and the surface layer rests on thin, variable layers of sandy and loamy alluvium. Lime occurs between a depth of 5 and 15 inches.

The soils of this unit are occasionally flooded for short periods, but they have good surface drainage and good internal drainage. They are difficult to farm because they are cut into small patches by the many channels and steep banks. The main hazards are streambank erosion and flooding. Because of these hazards, almost all of the acreage is in native grass. Scattered native trees and shrubs are common. These soils are excellent for trees. (Capability unit VIe–Si, Silty range site)

Valentine Series

The Valentine series consists of deep, very sandy soils in areas of undulating and hummocky uplands. The only large area of these soils is about 9 miles southwest of Dickinson.

The surface layer is very dark grayish-brown or dark grayish-brown, loose, noncalcareous loamy sand or loamy fine sand, generally about 4 inches thick. This layer contains only enough fine particles to hold the sandy material together in weak crumb structure. The aggregates break easily to single grains. An abrupt boundary separates the surface layer from the soil material below.

The soil material beneath the surface layer consists of one or more layers of olive-brown and light olive-brown, loose loamy fine sand or sand that is single grained and is free of lime to a depth of 60 inches or more.

The surface layer ranges from 3 to 8 inches in thickness. In some places the underlying material contains thin layers that are darker than normal. These are the former surface layer of an old soil that has been buried by drifting sand. The texture of the underlying material ranges from loamy fine sand to sand.

These soils are excessively drained, have low available moisture capacity, and are extremely susceptible to erosion by wind. Occasional dish-shaped blowout spots occur.

The Valentine soils are coarser textured and have a thinner surface layer than the Lihen soils. Unlike the Lihen soils, they lack a distinct subsoil. The Valentine soils are distinguished from the Flasher soils by their loose consistence and very sandy texture, and they formed in windblown material instead of in material weathered from soft sandstone. In contrast to the Banks soils, they are free of lime. Also, they are underlain by less stratified and less variable material that is not alluvial in origin.

Nearly all of the acreage of soils in this series has a cover of native grass and is used primarily for grazing. If the cover of grass is destroyed, these soils become unstable and erode, and soil material drifts into other areas.

Valentine fine sand, hilly (3 to 20 percent slopes) (VaE).—This is the only Valentine soil mapped in the county. It is on irregular, choppy slopes that are mainly between 8 and 12 percent in gradient. From 65 to 75 percent of the acreage consists of Valentine fine sand, and 15 to 30 percent, of Lihen loamy fine sand.

Grazing should be closely controlled to prevent further blowout spots from forming. Areas that now lack a cover of grass should be protected by a mulch of straw and seeded so that permanent vegetation can be established. This soil is not suited to trees. (Capability unit VIIe–CS, Choppy Sands range site)

Vebar Series

In the Vebar series are deep, well-drained, moderately coarse textured soils that are gently undulating to strongly sloping. These soils occur throughout the county on uplands and stream terraces. They developed in material weathered from soft sandstone.

Generally, the surface layer is very dark grayish-brown, very friable fine sandy loam that is free of lime and is about 10 inches thick. It has fine crumb structure that breaks to single grains.

The subsoil is very friable, nonlimy fine sandy loam that has weak, coarse, prismatic and blocky structure and is about 25 inches thick. The upper part is dark brown or dark grayish brown, but the color grades to light olive brown in the lower part of the subsoil.

The underlying material is soft, limy sandstone that breaks easily to fine sandy loam or loamy fine sand that is single grained and is light olive gray to light olive brown.

In areas that are not severely eroded, the surface layer is 5 to 10 inches thick, but it is thinner in a few severely eroded areas. The texture of the surface layer is sandy loam in some places, and the color ranges from dark brown to very dark grayish brown. The subsoil ranges from 20 to 36 inches in thickness, and the texture in parts of the subsoil is loamy fine sand in many places. In some areas the substratum contains thin layers of sandy gravel and gravelly sand.

These soils take in water readily and have fair available moisture capacity. They are fertile, but they are highly susceptible to wind erosion. Water erosion is also a hazard where the slopes have a gradient of more than 6 percent.

The Vebar soils occur with the Morton and Arnegard soils, but they have a coarser textured surface layer and subsoil than those soils. They have a thinner surface layer and a thinner, slightly lighter colored subsoil than the Parshall soils. The Vebar soils have a more distinct subsoil than the Lihen soils, and the texture of their profile is fine sandy loam instead of loamy fine sand. Their profile is thicker than that of the Flasher soils.

Approximately 65 percent of the acreage of Vebar soils is cultivated. These soils are well suited to a cropping system consisting of corn and small grains grown in rotation.

Vebar-Flasher fine sandy loams, strongly sloping (9 to 12 percent slopes) (VfD).—This complex consists mainly of deep Vebar soils and thin Flasher soils that occur in such an intricate pattern that separation is not practical. In most places the Vebar soil is on the lower two-thirds of the slope. The Flasher soil is on the upper part and on the crests of ridges and hills. From 45 to 55 percent of the acreage is Vebar fine sandy loam, 20 to 35 percent is Flasher fine sandy loam, and 10 to 20 percent is Lihen loamy fine sand and Gravelly land. The profiles of these soils are like the ones described for their respective series.

The soils of this complex are moderately eroded in some places. Trails made by cattle have caused serious gullying in some of the swales and drainageways. Cross fencing and deferred grazing can be used to protect these areas. Fair yields are obtained in the areas that are cultivated. Intensive practices to control erosion must be used, however, to maintain the productivity of the soils. These soils are not suited to trees. (Capability unit IVe–3, Sandy range site)

Vebar-Manning fine sandy loams, sloping (6 to 9 percent slopes) (VmC).—The soils of this complex are on the side slopes of high terraces that are 100 to 200 feet above the level of the present flood plains. They are south and east of Gladstone. From 40 to 50 percent of the complex is Vebar fine sandy loam, and 30 to 40 percent is Manning fine sandy loam. An additional 15 to 30 percent consists of Gravelly land.

The surface layer and subsoil of the Vebar soil are slightly thinner and lighter colored than those of the Manning soil. The upper part of the subsoil is dark grayish-brown, noncalcareous, very friable fine sandy loam that has prismatic and blocky structure. This material grades to olive-brown, noncalcareous, very friable loamy fine sand in the lower part of the subsoil. The thickness of the Vebar subsoil ranges from 20 to 26 inches. The substratum contains thin, nonlimy layers of gravelly loamy sand and loamy gravel.

The Manning soil has a surface layer of very dark grayish-brown, nonlimy fine sandy loam about 7 inches thick. Its subsoil is dark grayish-brown loam about 15 inches thick. The subsoil is underlain by a thick substratum of loamy gravel.

These soils are droughty, and wind erosion and water erosion are serious hazards where cultivated crops are grown. The soils are generally not cultivated but are fair for trees. (Capability unit IVe–3, Sandy range site)

Vebar-Parshall fine sandy loams, undulating (3 to 6 percent slopes) (VpB).—This complex consists mainly of

an intricate pattern of gently undulating and gently sloping Vebar and Parshall soils on uplands and stream terraces. The Vebar soils are generally on the slightly convex higher slopes, and the Parshall soils are on the slightly concave lower slopes. Both of these soils have a texture of fine sandy loam throughout the profile, but the Vebar soil is lighter colored and has a thinner surface layer and subsoil than the Parshall soil. From 40 to 55 percent of the complex is Vebar fine sandy loam, 25 to 35 percent is Parshall fine sandy loam, and 10 to 15 percent is Arnegard loam. In about one-third of the acreage, these soils have been moderately eroded by wind. In the eroded areas, 25 to 75 percent of the surface layer has been lost through wind erosion.

These soils are good for crops and are suited to small grains, corn, and tame grasses. Most of the acreage is cultivated. The main limitations of the soils are susceptibility to wind erosion and droughtiness. The soils are best suited to a rotation in which 1 year of corn is followed by 1 year of a small grain. Wind stripcropping should be practiced (fig. 12), and crop stubble ought to be left on the surface between growing seasons to help control wind erosion. Single-row windbreaks also reduce the velocity of the wind at the surface. These soils are fair for trees. (Capability unit IIIe-3, Sandy range site)

Vebar-Parshall fine sandy loams, sloping (6 to 9 percent slopes) (VpC).—These soils occur on sloping and undulating sandy uplands, generally with the Flasher soils (fig. 13). They are widely distributed throughout the county. The Vebar and Parshall soils are about equal in extent, and Flasher fine sandy loam and Lihen loamy fine sand occupy a smaller acreage. The Flasher soil makes up 10 to 20 percent of the acreage mapped as this complex, and the Lihen soil makes up 10 to 15 percent. About one-third of the acreage is moderately eroded. In the eroded areas, these soils have lost from 25 to 50 percent of their original surface layer.

The profiles of the Vebar and Parshall soils differ mainly in color and in the thickness of their surface layer and subsoil. The Vebar soil has a surface layer of very dark grayish-brown fine sandy loam, about 6 inches thick, and a subsoil of olive-brown fine sandy loam about 20 inches thick. Lime occurs only in the lower part of the substratum. The Parshall soil has a surface layer about 12 inches thick, and that soil contains more organic matter and is darker colored than the Vebar soil. Its subsoil is

Figure 12.—Wind stripcropping of alternate strips of small grains and summer fallow in a field of Vebar-Parshall fine sandy loams, undulating. The Vebar and Parshall soils in the foreground have been rough tilled to help in the control of erosion.

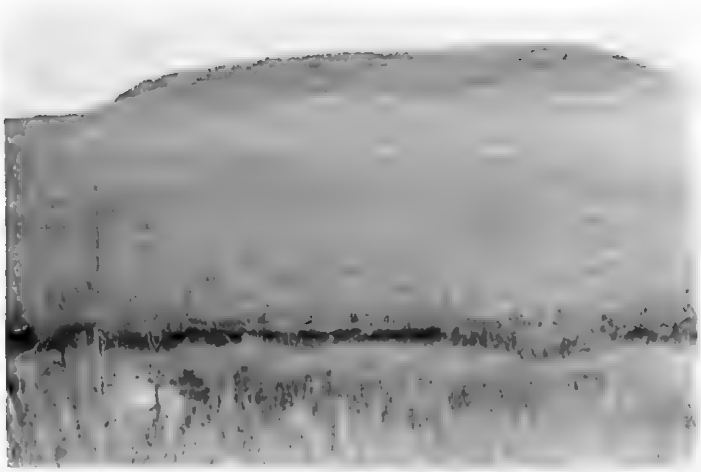

Figure 13.—Vebar-Parshall fine sandy loams, sloping, in range that is in good condition. Vebar soils are in the foreground, and Flasher soils are on the hill in the background.

very dark grayish-brown fine sandy loam about 28 inches thick.

The soils of this complex are droughty and are highly susceptible to wind erosion. In places they are also susceptible to water erosion. About half of the acreage is in range. Where cultivated crops are grown, intensive practices are required to maintain the productivity of the soils. Tame grasses grow well and give good returns when they are pastured. These soils are fair for trees. (Capability unit IVe-3, Sandy range site)

Wet Alluvial Land

Wet alluvial land (0 to 1 percent slopes) (Wa) is in intermittent drainageways and on flood plains along the larger streams. It consists of very poorly drained soil material in depressions and abandoned stream channels. The areas are kept wet by seepage and surface runoff during the major part of the growing season. The vegetation is wetland sedges and rushes. Open water is ponded in the center of some of the areas.

The soil material at the surface consists of mixed alluvial deposits that range from sandy loam to clay loam in texture. Beneath this material are thin layers of calcareous material that is mottled with reddish brown, gray, and yellow and ranges in texture from sandy loam to silty clay.

This land type occurs with the Straw and Havre soils, and all of it is in range. It is suitable for grazing and for wildlife areas but is not suitable for trees. (Capability unit Vw-WL, Wetland range site)

Wibaux Series

In the Wibaux series are shallow, loamy soils of the uplands that developed in material weathered from red clinkers, or scoria. These soils are sloping to steep. They are mainly on the caps of hills and buttes in the northwestern part of the county.

The surface layer is dark-brown or dark reddish-brown, friable, noncalcareous loam about 6 inches thick. It has fine blocky or crumb structure and contains a few pieces of hard scoria.

The surface layer rests directly on the substratum of scoria, a hardened, platy, bricklike material. The characteristics of this material developed in the geologic past when areas of bedded silty shale were heated and baked by buried deposits of burning lignite coal.

The surface layer ranges from 2 to 15 inches in thickness. In many places the lower part of this layer is a mixture of reddish-brown loam and small pieces of red scoria that are shaped like a plate. The substratum ranges from 2 to 20 feet in thickness and consists of thin layers of red, pink, and pinkish-white material. In some places the scoria is only slightly fractured and resembles bedrock. In other places it has been broken into small pieces and is as porous as coarse gravel. In many places the areas that are only slightly fractured are limy.

These soils are excessively drained and have low available moisture capacity. They are droughty and low in fertility.

The Wibaux soils occur with the moderately deep Searing soils and developed in the same kind of material. They differ from the Searing soils in lacking a distinct subsoil. The Wibaux soils are redder than the Bainville and Midway soils, and unlike those soils, they have pieces of scoria in the substratum.

Wibaux soils (4 to 20 percent slopes) (Wb).—These are the only Wibaux soils mapped in Stark County. They are gently sloping to strongly sloping and are on the crests of hills and ridges in the uplands. In places red clinkers crop out at the surface. From 75 to 95 percent of this mapping unit is Wibaux loam, and 10 to 15 percent is Searing soils.

Several areas of these Wibaux soils are mined for road-surfacing material taken mainly from shallow open pits. The material is excavated by using mechanical loaders, and it is used to improve private and secondary roads. The areas that are not mined are used for grazing. These soils are not suited to trees. (Capability unit VIIs-VS, Very Shallow range site)

Use and Management of Soils

The soils of Stark County are used mainly for cultivated crops and for tame pasture or native grass. This section explains how the soils may be managed for these main purposes and gives the predicted yields per acre of the principal crops grown under two levels of management. In addition it explains how the soils can be managed for planting trees in windbreaks, providing habitats for wildlife, and building highways, dams, and similar engineering structures.

Capability Groups of Soils

Capability classification is the grouping of soils to show, in a general way, their suitability for most kinds of farming. It is a practical classification based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment.

The soils are classified according to degree and kind of permanent limitation, but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soils; and without consideration of possible but unlikely major reclamation projects.

CAPABILITY CLASSES, the broadest grouping, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. Soils in class I (none in Stark County) have the fewest limitations, the widest range of use, and are subject to the least risk of damage when they are used. Soils of class II have limitations that moderately reduce the choice of plants or that make some conservation practices necessary. Soils of class III have severe limitations that reduce the choice of plants, make special conservation practices necessary, or both. Soils in class IV have very severe limitations that restrict the choice of plants, make very careful management necessary, or both.

Soils in classes V, VI, VII, and VIII have limitations that are difficult to remove without major reclamation; their use is restricted largely to pasture, range, woodland, recreation, or wildlife food and cover. Soils in class V are not likely to erode, but they are wet or have other unfavorable features that prevent normal tillage for cultivated crops. Soils in class VI generally are not suited to cultivated crops, because they are steep, susceptible to severe erosion, droughty, or otherwise severely limited. Soils in class VII are more limited than those in class VI, but under careful management they can safely be used for pasture or range, wood crops, or wildlife food and cover. In class VIII are soils and landforms so rough, shallow, or otherwise severely limited that they produce very low yields of crops, forage, or wood products. Such areas may provide attractive scenery, have value as catchment basins for water, serve as sites for recreation, or furnish food and cover for wildlife.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited, mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only subclasses indicated by *w*, *s*, and *c*, because the soils in it are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-4 or IIIe-6. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation, and the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph. The Arabic numeral, and for some capability units also a capital letter, specifically identifies the capability unit within each subclass. In the following pages the capability units in Stark County are described and suggestions for the use and management of the soils are given.

CAPABILITY UNIT IIc-6

In this capability unit are deep, well-drained soils that have slopes of 0 to 3 percent. These soils have a surface layer of very dark grayish-brown, friable loam to clay loam and a permeable subsoil. Water enters them easily, but they are limited by the climate.

The soils of this unit are the most productive and the most easily managed of any of the soils in the county. They are only slightly susceptible to wind and water erosion. Their fertility is naturally high, but the supply of plant nutrients may be somewhat depleted through years of cropping.

A suitable cropping system is fallow or corn the first year and then small grains for 1 or 2 years. Good tilth and the content of organic matter can be maintained by returning all the crop stubble and roots to the soils and by growing an occasional green-manure crop. Crop residue should be left on the surface when the soils are left fallow in summer or are tilled in fall. Wind stripcropping, instead of the crop residue, may also be used to control wind erosion. Seeding grass in the shallow drainageways may be necessary where water from runoff causes washouts and small gullies. A fertilizer containing phosphorus and nitrogen ought to be applied in the amounts indicated by the results of soil tests. Such a fertilizer helps plants make good growth and helps them make the maximum use of the available soil moisture. Lime is not needed on these soils.

Windbreaks grow well on these soils. The windbreaks help to reduce the surface velocity of the wind, reduce surface evaporation, and distribute drifting snow more evenly.

CAPABILITY UNIT IIe-4

Deep, nearly level silty clay loams and silty clays of the uplands and stream terraces make up this capability unit. The soils are moderately susceptible to wind erosion and are slightly susceptible to water erosion. They take in water at a moderate rate, but they have a slowly permeable subsoil. Their potential for storing additional moisture is good.

Small grains make good yields on these soils. Corn for silage grows fairly well, but the most suitable cropping system consists of 1 or 2 years of small grains followed by 1 year of summer fallow. On these soils stubble standing after harvest is needed for control of wind erosion. Leaving the residue of crops and weeds on the surface also protects the soils during periods of summer fallow. Wind stripcropping makes stubble mulching more effective. The rate at which water is taken in may be increased by returning all crop residue and manure to the soils and by including legumes occasionally in the cropping system. Commercial fertilizer ought to be applied in the amounts indicated by the results of soil tests. Where water from runoff concentrates, grassed waterways should be established.

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CAPABILITY UNIT IIe-5

This capability unit consists of deep, loamy Havre and Manning soils that take in water at a moderate rate. These soils are moderately susceptible to wind erosion. The Havre soil is also subject to water erosion caused by occasional stream overflow. The soils are nearly level and are only slightly eroded, are easily worked, and have high natural fertility. They have a sandy and gravelly substratum that does not seriously limit the storage of moisture but that does provide good internal drainage.

All the small grains, corn, hay crops, and specialty crops commonly grown in the area grow well on these soils; the Havre soil is well suited to alfalfa because in most places it is deep to the temporary water table. The cropping system best suited consists of corn and small grains grown in alternate years. Wind erosion can easily be controlled by wind stripcropping and stubble-mulch tillage. Returning crop residue to the soils and applying commercial fertilizer properly in the amounts indicated by the results of soil tests are equally important in managing these soils.

CAPABILITY UNIT IIIe-3

In this capability unit are deep, moderately coarse textured, friable soils that are easily eroded by wind. These soils are on the uplands and stream terraces, and they are nearly level and gently undulating. Their subsoil and substratum are moderately sandy and take in water at a moderate rate. Only a small amount of water runs off, and water erosion is not a hazard.

The cropping system best suited to these soils consists of corn and small grains grown in alternate years. If the corn grown for silage cannot be used in the farm enterprise, summer fallow may be substituted. Wind erosion can be controlled by managing the crop residue properly (fig. 14), practicing wind stripcropping, and protecting the soils with pattern-type windbreaks. All the straw and stubble should be returned to the soils so that the present good soil tilth and capacity for storing available moisture are maintained. As a rule, a fertilizer containing both nitrogen and phosphorus gives the greatest increase in yields. Testing samples of the soils in each field, however, will indicate the specific kinds and amounts of fertilizer needed. It is desirable, but not essential, for good management of these soils that grasses and legumes be included in the cropping system.

Figure 14.—Field of Vebar-Parshall fine sandy loams, undulating. These soils are protected by a stubble mulch while they are fallow in summer.

CAPABILITY UNIT IIIe-3M

The soils of this unit are deep, gently undulating and undulating fine sandy loams that have a subsoil of sandy clay loam. Where they have slopes greater than 4 percent, they are subject to serious water erosion. The less sloping areas and the areas on the crests of hills are mainly susceptible to wind erosion. Many of the areas that are cultivated are already eroded. In the eroded areas, these soils show a decline in fertility greater than that in other eroded, deep, sandy and loamy soils in the county. Their supply of organic matter is low, especially in the areas that are at least moderately eroded. These soils take in water at a moderate rate, but their capacity for storing available moisture is moderately low.

These soils are suited to wheat, barley, oats, corn, and tame grasses. A suitable cropping system is one in which the soils are summer fallowed every other year and corn is grown in the alternate years. Practices that control wind and water erosion are essential in maintaining the productivity of these soils. Generally, field strips that run across the general slope are more practical for these soils than contour stripcropping. Tilling up and down the slope usually causes rill and sheet erosion.

The supply of organic matter can be maintained or increased and the structure of the soils can be maintained or improved by returning all crop residue to the soils and including alfalfa and crested wheatgrass in the cropping system. Commercial fertilizer should be applied to small grains that follow corn or summer fallow. The kinds and amounts to apply should be determined by testing the soils.

CAPABILITY UNIT IIIe-3P

This capability unit consists of moderately deep, well drained Beckton soils that have a surface layer of fine sandy loam and a subsoil of sandy clay. The subsoil contains a claypan that restricts the penetration of moisture and roots. The substratum is saline bedded shale and is at a depth of about 24 inches.

A severe hazard of wind erosion limits the use of these soils for crops. In places the soils are already slightly to moderately eroded. The yields of crops are also reduced by the limited supply of soil moisture and plant nutrients and by the salts in the subsoil and substratum.

Areas of these soils provide good grazing where they have been left in native grass. Some fields that were formerly cultivated have been reseeded to crested wheatgrass, which makes good pastures for grazing in spring and early in summer. Yields of small grains are only fair on these soils. Intensive erosion control practices are needed to prevent serious losses from wind erosion. These ought to include wind stripcropping and leaving the grain stubble standing throughout the winter. Where wind stripcropping is practiced, the strips should be narrow. Grasses and legumes are important in the cropping system, for they increase the intake of water and the content of organic matter in these soils. Summer fallow is more beneficial for the succeeding crops than is corn.

These soils generally contain less available phosphorus and nitrogen than most of the arable soils of the county. Even though their yield potential is not high, applications of fertilizer are generally warranted.

CAPABILITY UNIT IIIe-4

In this capability unit are deep and moderately deep, well-drained silty clay loams and silty clays that are gently sloping and sloping. These soils are limited in use for crops by the moderate hazard of wind erosion and the severe hazard of water erosion. Some of the areas are already moderately eroded. The soils have good capacity for storing available moisture, but the rate of runoff is moderately rapid. In some places the soils receive runoff from steep areas of Bainville and Midway soils. Permeability is moderate to slow.

Although these soils are susceptible to water erosion, their long slopes are generally well suited to terraces or contour stripcropping. If grassed waterways are established and crop residue is well managed, water erosion usually can be controlled by installing terraces and practicing contour stripcropping. Diversion dikes that intercept the runoff from the Bainville and Midway soils can be used to supplement the contour stripcropping.

A suitable cropping system is small grains for 1 or 2 years and summer fallow for 1 year. Improving the soil tilth and increasing the intake of water are directly related to the control of water erosion and should be considered in the management of these soils. Returning all straw or other crop residue to the soils improves the soil tilth and increases the intake of water. Including legumes and grasses in the cropping system also improves the tilth. Applications of commercial fertilizer are generally warranted if the soils are tested to determine the kinds and amounts needed.

CAPABILITY UNIT IIIe-6

This capability unit is made up of deep, friable soils that have a surface layer and subsoil of loam to silty clay loam. The use of these soils for growing cultivated crops is limited by the hazard of water erosion, as a result of the moderately rapid runoff. In places more than half of the original surface layer has been lost through erosion. Erosion is especially evident on some of the upper slopes and in the small drainageways. These soils are fertile, however, and have good capacity for storing available moisture, are easily worked, and are well drained. Their substratum varies greatly from one soil to another, but this layer does not restrict the penetration of roots and water. The slopes range from 3 to 9 percent.

A well-suited cropping system is corn or summer fallow the first year followed by small grains for 1 or 2 years. Specialty crops, such as safflower or grass grown for seed, and tame grasses for hay or pasture also do well. Tillage practices or practices that reduce runoff and water erosion are needed in managing these soils. Stubble-mulch fallow, contour stripcropping (fig. 15), terracing, and grassed waterways are needed in most of the areas. Wind erosion is not a serious hazard. It is usually controlled where these soils are protected from water erosion. Including grasses and legumes in the cropping system improves the tilth of the soils and the intake of moisture.

Figure 15.—**A field of Morton-Chama silt loams, sloping, where contour stripcropping is practiced. The cropping system used for the control of erosion is alternate corn and small grains.**

Commercial fertilizer gives fair to excellent increases in yields. The kinds and amounts of fertilizer to use should be based on the needs indicated by the results of soil tests and on the history of past management of these soils.

CAPABILITY UNIT IIIe-6P

In this capability unit are moderately deep and shallow, slowly permeable panspot soils and deep, medium-textured and moderately fine textured soils of the uplands. The pattern and distribution of each kind of soil is patchy. The slopes range from 3 to 9 percent, and as a result all of the soils are susceptible to water erosion. The panspot soils are also saline and droughty, and they take in water at a moderate to very slow rate. Sheet erosion and small rills and gullies are common in most cultivated fields.

A cropping system well suited to these soils is summer fallow the first year and small grains the second year. However, including alfalfa and tame grasses in the cropping system and growing them for a period of 4 to 6 years is beneficial. Crop residue left on the surface helps to control erosion, increases the intake of water, and reduces soil crusting. The long slopes are generally suitable for contour stripcropping. Grassed waterways should be established where water from natural drainage concentrates and runs off.

Deep tillage temporarily benefits the panspot soils by increasing the intake of water and leaching out the salts. Generally needed is stubble mulching to protect the soils from wind erosion during fallow periods. A commercial fertilizer high in content of phosphorus normally gives good increases in yields where the cropping system includes periods of fallow.

CAPABILITY UNIT IIIes-3

In this capability unit are moderately deep soils that are nearly level and gently sloping. These soils are moderately sandy and are underlain by a droughty substratum of gravelly material and coarse sand. They are on terraces adjacent to the escarpment along the valley of the Heart River.

The two main limitations to the use of these soils for crops are susceptibility to wind erosion and droughtiness. Water is absorbed by the surface layer and subsoil

at a moderate rate. It is rapidly absorbed by the substratum. The available moisture capacity is moderately low.

The fields in which these soils occur should be farmed in narrow strips, and grain stubble ought to be left undisturbed throughout the winter. Seeding should be done immediately after the seedbed is prepared in spring, so that moisture will be conserved.

A suitable cropping system is corn the first year and small grains the second year. The available moisture capacity is generally too low to warrant including summer fallow in the cropping system. Where the soils are especially weedy, however, they may be left fallow in summer and protected by a stubble mulch. Moderately eroded areas can be improved by applying any available barnyard manure. A fertilizer containing nitrogen and phosphorus is needed for the highest yields.

CAPABILITY UNIT IIIes-4

In this capability unit are moderately deep, clayey soils that have slopes of 3 to 9 percent. These soils have a crust on the surface after they dry. Freezing and thawing of the bare surface layer late in winter and early in spring cause the granular soil material to loosen. As a result, these soils become highly susceptible to erosion by wind. Erosion has already removed from 25 to 50 percent of the surface layer in about one-third of the acreage. The soils are also subject to water erosion. They have salts in the subsoil and are slowly permeable.

In spite of the adverse soil characteristics, yields of small grains are fair to good on the soils of this unit. The most successful cropping system is summer fallow the first year and wheat or barley the second year. Needed are management practices that conserve moisture, control water erosion, and maintain or increase the supply of plant nutrients. Among the practices that are suitable are tilling across the slope or stripcropping on the contour, protecting the soils with a stubble mulch while they are fallow in summer, constructing diversion dikes and grassed waterways, and applying fertilizer in the amounts indicated by the results of soil tests. Growing legumes for hay or for green manure improves the permeability of these soils and allows moisture to penetrate more readily. Contour stripcropping helps to control water erosion, and stubble-mulch tillage provides adequate control of wind erosion.

These soils are well suited to range. If additional grazing land is needed, it can be obtained by reseeding to western wheatgrass, green stipa, and slender wheatgrass the fields formerly used for crops.

CAPABILITY UNIT IIIes-5

In this capability unit is a moderately deep soil, Searing loam, that is susceptible to wind erosion and has a droughty substratum. This soil is nearly level to sloping, and it has a surface layer and subsoil that are loamy. The subsoil is underlain by scoria, or reddish-colored clinkers, at a depth of nearly 20 inches. This coarse-textured underlying material restricts the development of roots. Natural fertility is moderate.

This soil is well suited to tame grasses for grazing in spring. It can be grazed for several years, and then it may be used for cultivated crops. A cropping system of alternate corn and small grains is suitable and fits well into the system of management. Wind stripcropping is a good practice where the corn and small grains are grown. All the crop residue ought to be returned to the soil to increase the water-holding capacity.

Summer fallowing this soil is of doubtful value where that practice is used only for storing extra soil moisture. Leaving over winter the stubble of the small grain and two to four rows of corn stubble standing in each strip is one of the most effective ways of conserving moisture. In many years the amount of snow caught by this crop residue is great enough to bring the content of moisture up to field capacity in the uppermost 1 foot of the soil. Single-row field windbreaks are also effective in catching and holding snow where it falls and in reducing the surface velocity of the wind. Applying at the optimum rate a fertilizer containing nitrogen and phosphorus helps crops make more efficient use of the available soil moisture.

CAPABILITY UNIT IIIse-4

In this capability unit are moderately deep, clayey soils that have slopes of 0 to 3 percent. These soils take in water slowly, are slowly permeable, and have a subsoil that contains salts. Because of freezing and thawing late in winter and early in spring, a loose, granular structure forms in their surface layer, and as a result, these soils are easily eroded by wind. Also, they are susceptible to erosion by water.

Fair to good yields of small grains are obtained on these soils, but the crop yields are lowered by the content of salts in the subsoil. Good management and adequate soil moisture are vital if above-average yields are to be obtained. A suitable cropping system is summer fallow the first year and wheat or barley the second year. However, legumes grown in rotation with small grains improve the structure of the soils. Stubble-mulch fallow practiced in conjunction with wind stripcropping adequately controls wind erosion. Water erosion is a hazard, mainly in the drainageways. Therefore, to eliminate rills and washouts, the drainageways should be seeded to grasses that form a sod. Commercial fertilizer ought to be applied in the amounts indicated by the results of soil tests.

CAPABILITY UNIT IIIs-5P

This capability unit is made up of moderately deep and shallow panspot soils mixed with deep, medium-textured and moderately fine textured soils of the uplands and stream terraces. The pattern and distribution of each kind of soil is patchy. The areas of panspot soils are 10 to 40 feet in diameter and are saline and droughty. The slopes range from 0 to 3 percent.

The soils of this capability unit are moderately susceptible to wind erosion and slightly suspectible to water erosion. They take in water at a moderate to very slow rate. Small rills and gullies have formed in a few of the drainageways that cross areas of these soils.

A suitable cropping system is summer fallow the first year and small grains the second year. Leaving crop residue on the surface over winter and during the period of fallow is essential for controlling wind erosion. This practice also increases the amount of water taken in because it reduces crusting of the surface layer.

Although these soils are nearly level or gently sloping, tilling or performing other farming operations across the slope reduces the hazard of water erosion and increases

the amount of moisture that enters these soils. Deep tillage is beneficial where small grains are to be grown. The benefit is of short duration, however, and ought to be repeated every 2 years. A commercial fertilizer containing phosphorus and nitrogen should be applied in the amounts indicated by the results of soil tests.

CAPABILITY UNIT IIIs-6R

In this capability unit are moderately deep, nearly level and gently sloping silt loams on the tops of buttes. These soils are permeable and are easily worked. They have a subsoil of loam or silt loam that has moderate available moisture capacity, but their substratum is limestone bedrock that restricts the penetration of roots. The moderate depth of the soils and their suspectibility to wind erosion are the main limitations to their use for crops.

A suitable cropping system is corn or summer fallow the first year followed by small grains for 1 or 2 years. These soils are also suited to tame grasses grown for hay and pasture. Leaving stubble on the surface during periods of summer fallow is the best way of conserving the soil moisture and of protecting these soils from wind erosion. Stripcropping also helps to control wind erosion, but water erosion is not a hazard. Returning to the soils all the crop stubble after the period of summer fallow helps to maintain good soil tilth. Commercial fertilizer ought to be applied in the amounts indicated by the results of soil tests.

CAPABILITY UNIT IIIws-4

This capability unit is made up of the imperfectly drained, nearly level saline phase of the Grail soils in swales and drainageways in the uplands. These soils have a surface layer of loam or silt loam and a subsoil and substratum of mottled limy and salty silt loam or clay loam. A temporary high water table brings salts from the substratum to the surface layer.

The imperfect drainage and the moderately high content of salts are the main limitations to using these soils for crops. If the soils are used for cultivated crops, they are difficult to manage and are susceptible to water erosion. Seedlings fail to emerge and tillage is likely to be delayed by the excess moisture in the soils. Even in drier than normal years, yields of small grains grown on these soils are usually much lower than those of small grains grown on other soils in the same field. These soils are well suited to salt-tolerant tame and native grasses harvested for hay or pasture.

CAPABILITY UNIT IIIw-4

In this capability unit is a deep, clayey soil, Dimmick clay, in upland depressions. This soil was formerly poorly drained. Surface drainage has been installed, however, to remove the excess water and to permit timely tillage. The present management should include maintaining the present drainage system, controlling wind erosion, and applying the proper kinds and amounts of fertilizer.

This soil can be used for cultivated crops, but it is difficult to manage. A suitable cropping system is small grains the first and second years and summer fallow the third year. The small grains make good to excellent yields after this soil is drained. Wind erosion is a moderate hazard, but it can be easily controlled by leaving crop residue on the surface between growing seasons. Without artificial drainage, this soil is better suited to hay and pasture than to field crops.

CAPABILITY UNIT IVe-2

In this capability unit is a nearly level or undulating, sandy Lihen soil of the uplands and stream terraces. The surface layer and subsoil are loamy fine sand, but the texture of the substratum varies. This soil is easily worked, but it is easily eroded by wind and is droughty. It has low moisture-holding capacity and is rapidly permeable.

This soil is better suited to pasture than to cultivated crops, and both tame and native grasses make good yields. The severe hazard of wind erosion makes management of this soil difficult if cultivated crops are grown. If this soil is to be safely used for cultivated crops, a combination of wind stripcropping, stubble-mulch tillage, and field windbreaks is needed. A suitable cropping system is one in which corn and oats are grown in alternate years and then tame grasses and legumes are grown for several years. The crops should be grown in narrow strips.

Even though the best farming methods are used, yields are likely to be low on this soil because of the limited supply of available moisture. Barnyard manure, applied regularly, improves the tilth, supplies plant nutrients, and increases or maintains the present moisture-holding capacity.

CAPABILITY UNIT IVe-3

In this capability unit are deep fine sandy loams of the uplands and stream terraces. These soils have slopes of 6 to 12 percent. The texture of their subsoil and substratum ranges from sandy clay loam to loamy sand, but fine sandy loam is predominant.

These soils are easily worked, but they are easily eroded by wind and are susceptible to water erosion in places. In about 30 percent of the acreage, from 25 to 75 percent of their surface layer has already been lost through erosion. These soils also have a moderately low capacity for storing available moisture.

A suitable cropping system is corn and small grains grown in alternate years in strips 5 to 10 rods wide. The strips should be run across the predominant slopes. Yields are only fair. The most successful planting method consists of plow-planting the corn and using a pony-press drill to seed the small grains. Grain stubble left undisturbed on the surface throughout the winter provides excellent protection from erosion and catches snow that will provide additional moisture. Including tame grasses in the cropping system improves the tilth of the soils and adds organic matter. A fertilizer containing nitrogen and phosphorus should be applied in the amounts indicated by the results of soil tests.

CAPABILITY UNIT IVe-4L

This capability unit consists of sloping or strongly sloping, loamy soils of the uplands. The surface layer of these soils is thin and light colored, and it has a high content of lime. The areas that have been cultivated are slightly to moderately eroded. The slopes range from 6 to 12 percent.

Wind erosion is a severe hazard in areas of these soils on the crests of hills, and water erosion is a hazard on the side slopes in cultivated fields. The soils take in water well to a depth of 6 to 15 inches, but the rate of intake is slow below that depth. Runoff is rapid. Generally, the content of nitrogen and available phosphorus is low.

About 40 percent of the acreage is cultivated. In the rest of the acreage, the soils have a good cover of grass and are in range. These soils should be cultivated for only short periods of 2 to 5 years. Then, for the next 3 years, they should be kept in tame or native grasses grown for hay or pasture. Such a cropping system maintains a reasonable amount of organic matter in the surface layer.

Where the soils are not intermittently seeded to grass, the best cropping system is summer fallow the first year and small grains the second year. Diversion terraces, field terraces, and contour stripcropping help to conserve moisture and provide protection from erosion. Whether those practices can be justified, however, depends on the returns versus the cost and on the type of farming enterprise. Tilling up and down the slope is not a good practice on these soils, because it causes severe erosion and loss of moisture.

CAPABILITY UNIT IVe-4P

In this capability unit are complexes of deep and moderately deep, sloping soils and shallow panspot soils of the uplands. The panspot soils occur in small patches, and they are saline and droughty. In the comparatively short time these soils have been cultivated, they have lost from 50 to 75 percent of their surface layer through erosion. Further damage from water erosion is a severe hazard during heavy rains and thunderstorms. Also, where these soils are not protected late in winter and early in spring, they are moderately susceptible to wind erosion.

A cropping system in which tame grasses are grown for several years is needed if these soils are to be used for growing small grains. Stubble mulch should be kept on the surface during periods of fallow, and crop residue ought to be left on the surface throughout the winter after the crop is harvested. Greater returns may be received from these soils where they are seeded to permanent hay or pasture than where they are used for field crops. This is because yields of small grains are only fair but yields of perennial grasses are good. Also, where these soils are used for grass, they are less susceptible to erosion than where they are used for cultivated crops, and their other limitations are less severe. Where the soils are used for grass, stocking the range at a suitable rate and using the forage properly are the main goals of management.

CAPABILITY UNIT IVws-4

In this capability unit are poorly drained, shallow Hoven soils in flat-bottomed depressions, or basins, in the uplands. The surface layer is silty clay loam or silty clay, and the subsoil is dense clay.

The rate at which water is taken in is slow, and the amount of runoff is low. Water is ponded on the surface during part of the growing season. Proper surface drainage is necessary before timely seeding and tillage can take place. In places salts in the subsoil and substratum limit yields of crops. Erosion is not a hazard.

Where drainage is not feasible, these soils are best kept in perennial grass. Where the soils have been drained, a suitable cropping system is summer fallow the first year and small grains the second and third years. The soils warm too slowly in spring for corn for silage to be included in the cropping system. Barnyard manure is needed to improve the tilth of these clayey soils.

CAPABILITY UNIT Vw-Ov

In this capability unit is a nearly level, deep, clayey soil, Gallatin clay loam, on bottom lands along the main streams. This soil is in depressions and oxbows. For short periods, surface ponding makes it too wet for cultivation. Its surface layer is very dark colored clay loam. Below the surface layer is mottled loam or clay loam. Erosion by wind and water is not a hazard.

Because of the extra moisture, hay makes good yields on this soil, and most areas are well suited to bromegrass and alfalfa for hay. During years of normal or below-normal rainfall, small grains that have been planted late also make good yields. In places it is feasible to construct open-ditch drains that hasten the removal of the excess water and reduce the damage to plants. Some areas have a cover of those native grasses that produce high yields of forage. The grasses tolerate excess moisture; therefore, drainage is not a problem. For more information about the use of this soil for range, see the description of the Overflow range site in the section "Use of the Soils for Range."

CAPABILITY UNIT Vw-Sb

In this capability unit is a nearly level, deep, dark-colored soil, Colvin silt loam, in swales. The surface layer of this soil is silt loam. Beneath the surface layer, the soil material is variable and is wet because of the high water table. Early in spring, water is sometimes ponded on the surface.

Poor drainage makes this soil suitable only for hay and pasture. Native grasses do well because of the extra moisture provided by subirrigation. Proper use and controlled grazing are the main practices needed when this soil is in pasture. A fertilizer that contains nitrogen and phosphorus can be applied in areas that are not extremely boggy. For more information about the use of this soil for range, see the description of the Subirrigated range site in the section "Use of the Soils for Range."

CAPABILITY UNIT Vw-WL

In this capability unit are areas of Dimmick clay that are not feasible to drain. Also included is a nearly level land type, Wet alluvial land, in depressions and stream channels on bottom lands and in flat basins in the uplands. The water table is high, and water stands on the surface during part or all of the growing season. For this reason, the areas are suitable only for hay, pasture, or wildlife habitats. The natural vegetation is wetland sedges and grasses that produce abundant forage.

Drainage is not feasible, and grazing and use as a wildlife habitat appear to be the best utilization. The range should be protected from overgrazing and grazed only during the proper seasons of use. For more information about use of these soils for range, see the description of the Wetland range site in the section "Use of the Soils for Range."

CAPABILITY UNIT VIe-Cy

This unit consists of gently sloping to strongly sloping sandy clay loams to clays of the uplands. These soils have a thin surface layer and subsoil and are underlain by shale or bedrock in some places. The slopes range from 2 to 15 percent. Excessive runoff, the hazard of water erosion, and bedrock near the surface are the main limitations.

These soils are better suited to pasture plants than to cultivated crops, and most of the acreage is in range. The management should include moderate grazing late in spring after the plants have made a 3- to 4-inch growth. Grazing ought to be distributed, and adequate water should be provided for livestock. Bare areas or areas where the range is in poor condition may need to be fenced or deferred from grazing for more than one season.

Part of the acreage of the Moreau-Rock outcrop complex is cultivated. These areas ought to be restored to pasture by seeding adapted species of native grasses early in fall or spring. Seeding directly into the stubble is the method suggested. For more information about use of these soils for range, see the description of the Clayey range site in the section "Use of the Soils for Range."

CAPABILITY UNIT VIe-Si

In this capability unit are mainly loamy, dark-colored soils adjacent to meandering stream channels. The soils are subject to streambank erosion. They have been cut into many small plots by the stream channels, and they are not accessible to modern machinery.

These soils are fertile and are easily penetrated by water and roots, but water erosion and stream overflow are serious hazards. The channels are difficult to cross; consequently, the areas are not suitable for annual tilled crops, but most of them are suitable for hay and pasture. Some of the larger ones, however, can be tilled and seeded to permanent tame hay, and the temporary water table provides a source of extra moisture for the hay.

Maintaining vigorous growth of the native or tame grasses is essential for protecting these soils. Where the areas are used for pasture, control of grazing is necessary. Also, some of the narrow or intermittent channels can be reshaped and reseeded so that they will be more accessible for mowing and crossing. For more information about use of these soils for range, see the description of the Silty range site in the section "Use of the Soils for Range."

CAPABILITY UNIT VIe-Sa

In this capability unit are very sandy, nearly level to rolling soils that have been severely eroded in places and that are highly susceptible to further wind erosion. Blowout spots and drifted soil material along the boundaries of fields are common. Water and roots penetrate these soils easily, but the natural fertility is low.

These soils are suited to permanent pasture or range. They should be managed so that sustained yields of forage will be obtained.

Areas that are now used for crops ought to be seeded to perennial grasses that are adapted to sandy soils. Preparation of the seedbed ought to be eliminated, and seeding should be done directly in the residue of crops or weeds. Bare, eroding spots should be mulched with straw before they are seeded. The primary plants named in the description of the Sands range site grow well in eroded areas that need reseeding. Applying commercial fertilizer may be warranted on these soils, but the fertilizer ought to be applied on a trial basis. For more information about use of these soils for range, see the description of the Sands range site in the section "Use of the Soils for Range."

CAPABILITY UNIT VIe-TSi

In this capability unit are sloping to steep loams and silty clay loams of the uplands. These soils are shallow over shale, and shale crops out in a few places. The main limitations are the severe hazard of erosion, low moisture-holding capacity, and excessive runoff.

These soils are suitable only for grazing and wildlife. In the areas in pasture or range, not more than half of the annual growth of forage should be grazed after the plants have made 3 to 4 inches of growth. Overgrazing of some areas and undergrazing of others may be avoided by developing additional watering facilities, changing salting stations, and building cross fences. Deferred grazing for 1 or more years is needed where the range is in fair or poor condition.

Because of the steep slopes, reseeding by drilling or broadcasting is impractical. Instead, existing sources of seed and deferred grazing should be relied on to maintain a good cover of grass. In places diversion ditches are needed in areas of these soils to protect the cropland on the lower slopes. For more information about use of these soils for range, see the description of the Thin Silty range site in the section "Use of the Soils for Range."

CAPABILITY UNIT VIe-TSy

This capability unit is made up of moderately sandy soils that are shallow over sandstone and have slopes of 9 to 35 percent. Nearly all of the areas have a cover of native grass, but there are a few bare spots where sandstone crops out. The condition of the stand of native grass varies. The main limitations to use of these soils for farming are susceptibility to wind and water erosion and low moisture-holding capacity.

The soils in this unit are suitable only for hay, grazing, or wildlife habitats. Wind erosion is a hazard only where these soils are tilled or the condition of the range has deteriorated. Water erosion is a hazard in bare areas or on trails that are used extensively. The areas in range should be grazed at a moderate rate. Also, grazing should be well distributed and should take place only during the proper seasons. Other practices that may be beneficial are distributing water for livestock in various parts of the range, installing cross fences, and deferring grazing. For more information about use of these soils for range, see the description of the Thin Sandy range site in the section "Use of the Soils for Range."

CAPABILITY UNIT VIs-Cy

This capability unit consists of moderately deep, clayey Moreau soils that occupy a small acreage in the southwestern part of the county. These soils are not suitable for tillage, because of the pieces of chert and flint on or near their surface.

These soils have a cover of native grass. Grazing is their main use, and yields of forage are good. For more information about use of these soils for range, see the

description of the Clayey range site in the section "Use of the Soils for Range."

CAPABILITY UNIT VIs-Si

In this capability unit is a deep, loamy, well-drained, gently sloping to strongly sloping soil, Morton stony loam, that is not suitable for tillage, because of the pieces of chert and flint on or near the surface. The stones are too numerous for economical removal.

A good growth of native grasses is produced on this soil. This soil ought to be used for grazing, and good range management should be practiced that will give sustained annual yields. For more information about use of this soil for range, see the description of the Silty range site in the section "Use of the Soils for Range."

CAPABILITY UNIT VIs-Ps

This capability unit consists of strongly saline-alkali soils of uplands and stream terraces. The concentrations of salts, poor soil tilth, and dense, clayey subsoil restrict the growth of plants. These soils are not suitable for cultivated crops; seedlings fail to emerge, growth of the plants is uneven, and yields are poor. The slopes range from 0 to 6 percent.

These soils are more suitable for range or for pastures of native grass than for cultivated crops. Areas now used for crops can be reseeded to western wheatgrass, blue grama, and other adapted grasses. Under good range management, fair to good yields of forage may be expected. Grazing ought to be avoided until the leaves have made a growth of 3 to 4 inches.

Nitrogen fertilizer can be applied on a trial basis to determine whether the increase in yields of forage is profitable. Contour pitting, furrowing, and other practices that reduce runoff are beneficial, as such practices permit a greater intake of moisture. Deferred grazing should be practiced and weeds controlled by mowing or spraying. For more information about use of these soils for range, see the Panspots range site in the section "Use of the Soils for Range."

CAPABILITY UNIT VIs-SS

Only the land type, Saline alluvial land, is in this capability unit. This land type is in drainageways and on nearly level stream terraces. The individual areas are generally small and occur in many parts of the county. The sparse vegetation and a light-gray or white crust on the surface distinguish the areas from the surrounding soils. The somewhat poor or poor drainage caused by a high water table affects the management. The slopes range from 0 to 3 percent.

Where the native grass has been removed, reseeding with grasses that tolerate salt should be attempted. Even when a stand of grass has been established in most places, however, some areas will be bare because of the high content of salts. Artificial seeding is generally not needed in the areas already in range, because the range plants supply a natural source of seed. The management practiced in managing other soils in the same range or pasture is also applicable to this land type. For more information about use of this land type for range, see the Saline Subirrigated range site in the section "Use of the Soils for Range."

CAPABILITY UNIT VIIe-CS

In this capability unit is a deep, sandy soil, Valentine fine sand, hilly, in small areas where the slopes range from 3 to 20 percent. The soil material is loose and is extremely erodible by wind. This soil is porous and coarse textured, and as a result, it is droughty. Blowout spots occur in some places.

This soil is best used for moderate to light grazing. The blowout spots may have to be excluded from grazing. They are troublesome and require a mulch of straw, fencing, and seeding of adapted grasses to stabilize them. For more information about use of this soil for range, see the Choppy Sands range site in the section "Use of the Soils for Range."

CAPABILITY UNIT VIIs-BL

A complex consisting of outcrops of soft shale and sandstone mixed with hilly and steep Bainville and Flasher soils makes up this capability unit. The slopes are as steep as 58 percent. Outcrops of bedrock make up 30 to 60 percent of each individual area where these outcrops occur, and, natural, or geologic, erosion is continuous. Susceptibility to erosion, low intake of water, rapid runoff, and low fertility are the main limitations to the use of these soils for crops.

Limited grazing is available on the soils of this unit, but yields of forage are low. The areas also provide a suitable habitat for deer and other species of wildlife. Where severe gullying occurs, fencing and complete deferment of grazing are needed to reduce accelerated erosion. For more information about use of these soils for range, see the Badlands range site in the section "Use of the Soils for Range."

CAPABILITY UNIT VIIs-SwG

In this capability unit is a shallow gravelly land type on high stream terraces and on the tops of steep valley escarpments along the Heart and Green Rivers. The slopes range from gentle to steep. The areas include gravel pits and spoil piles, as well as unmined areas. Droughtiness, low fertility, and the steep slopes are the main limitations to use of this land for crops.

This land type is suitable for grazing before mining takes place and after mining is completed. Reclaiming of the pits should include grading, spreading the material in the piles of spoil, and reseeding. Grazing should be allowed only in seasons when the grass is making its best growth. The adapted grasses are dormant during hot, dry periods, but they revive when the supply of moisture becomes more favorable. For more information about use of this land type for range, see the Shallow to Gravel range site in the section "Use of the Soils for Range."

CAPABILITY UNIT VIIs-TB

This capability unit consists of soils on steep escarpments along the edges of stream valleys. These soils are shallow over shale and sandstone, and 15 to 35 percent of the acreage is made up of bare outcrops of shale and sandstone. In the areas underlain by sandstone, the surface layer has a texture of loamy fine sand or fine sandy loam. In the areas underlain by shale, the texture of the surface layer is loam or clay loam.

These are droughty soils. The rate of runoff is high, and there is a severe hazard of water erosion. Winds continually erode the bare outcrops of sandstone.

These soils are suitable only for limited grazing and wildlife habitats. Grazing should be controlled, so that no more than half of the annual top growth is grazed. Overuse of some areas and underuse of others ought to be avoided by distributing watering places and salt. Cross fences may be needed in some pastures. Reseeding the bare areas and the areas that have only a sparse cover of grass is not practical. The plants now growing on these soils should be relied on to provide a source of seed. For more information about use of these soils for range, see the Thin Breaks range site in the section "Use of the Soils for Range."

CAPABILITY UNIT VIIs-VS

In this capability unit are loamy Wibaux soils that are shallow over reddish clinkers. These soils are on the crests of buttes and escarpments and have slopes that range from 4 to 15 percent. Droughtiness, low fertility, and a severe hazard of erosion are the main limitations to their use for farming.

Management of these soils should consist mainly of regulating grazing during each season, so that proper use will be insured. When the range is overgrazed, the plants lose their vigor, some areas lose their cover of plants, and gullying results. For more information about use of these soils for range, see the Very Shallow range site in the section "Use of the Soils for Range."

CAPABILITY UNIT VIIIs-1

Land types that are not suitable for field crops or range are in this capability unit. They consist of nearly bare outcrops of shale and piles of waste that produce little or no forage. Susceptibility to water erosion, low fertility, and steep slopes are the main limitations to use. The areas can be used only for limited grazing and wildlife habitats.

Predicted Yields

Table 2 gives estimated yields per acre for the crops commonly grown in Stark County. The yields are shown for two levels of management. The yields shown in columns A are to be expected under average management. Those shown in columns B are to be expected under improved management. Under both levels of management, wheat always follows corn or summer fallow in the cropping system. All the soils of the county have an adequate supply of lime for the crops commonly grown.

Following are the practices used to obtain the yields shown in columns A:

1. The cropping system consists of corn or summer fallow for 1 year, followed by small grains for 1 or 2 years.
2. Adapted varieties of crops are planted, and seed of good quality is used.
3. Tillage and planting operations are not always timely.
4. Erosion control practices are used to only a limited extent.
5. Insecticides and herbicides are applied occasionally.
6. The amount of commercial fertilizer applied is below the optimum rate.

Following are the practices used to obtain the yields shown in columns B:

1. The cropping system is corn or summer fallow for 1 year, followed by small grains for 1 or 2 years.
2. Adapted varieties of crops are planted, and seed of good quality is used.
3. Tillage and planting operations are performed at the best time.
4. Wind erosion and water erosion are controlled. All crop residue is returned to the soils.
5. Insecticides and herbicides are applied when needed.
6. Commercial fertilizer is applied according to the needs indicated by the results of soil tests.
7. Adequate drainage is provided.

Use of the Soils for Tame Pasture and Hay

Most of the soils in capability classes II, III, and IV are planted to cultivated crops each year. A considerable acreage of these soils, however, is used to grow grasses and legumes for hay and pasture. The pastures and meadows are used to produce forage to supplement that provided by the native range.

The areas in tame pasture and meadow are considered to be semipermanently converted from cropland. For those areas, periodic cultural treatments are needed in addition to proper grazing management. The soils may need tillage to prevent compaction or puddling of the surface soil. Occasionally, they need tillage, so that a seedbed can be prepared and the stand improved by reseeding the area. Applying fertilizer according to the results of soil tests is also important for maintaining the stand and producing forage. Mowing, scattering droppings, spreading water, and rotating grazing are all good management practices.

Introduced grasses and legumes make up most of the stand in the tame pastures and meadows. They generally consist of cool-season species grown for pasture and hay early in the growing season. Warm-season species are also grown, however, for grazing in summer and fall. The major species used for seeding are crested wheatgrass or smooth bromegrass, seeded alone, in mixtures, or with alfalfa.

Crested wheatgrass, Siberian wheatgrass, alfalfa, and sweetclover are the better species for seeding on the sandy and droughty soils of capability units IIIe-3, IIIe-3M, IIIe-3P, IIIes 3, IIIes-5, IIIs-6R, IVe 2, and IVe-3. In addition to these species, Russian wildrye, green needlegrass, western wheatgrass, and slender wheatgrass are suitable for the medium-textured and fine-textured soils in capability unit IIc-6, IIe-4, IIe-5, IIIe-4, IIIe-6, IIIs-5P, and IIIs-6R.

Bromegrass, western wheatgrass, intermediate wheatgrass, and switchgrass are suitable for soils that are irrigated or that receive supplemental moisture as a result of their position on the landscape. Creeping foxtail,

Table 2.—*Estimated average acre yields of the principal crops grown under two levels of management*

[Absence of yield figure indicates the soil is not suited or is not used extensively for the crop specified]

Soil	Wheat		Oats [1]		Barley [1]		Corn (fodder)		Alfalfa	
	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*
Arnegard loam, level	25	30	49	60	34	40	5.5	5.9	1.5	2.2
Arnegard loam, gently sloping	23	29	46	56	30	37	4.9	5.4	1.5	2.0
Bainville and Midway soils, undulating										
Bainville and Midway soils, steep										
Bainville and Midway stony soils										
Bainville-Rhoades complex, strongly sloping										
Bainville-Shale outcrop complex										
Banks and Glendive soils										
Beckton complex	12	14	27	34	18	21	2.0	2.2	1.2	1.5
Belfield-Rhoades loams, level	16	19	29	37	20	24			1.2	1.5
Belfield-Rhoades loams, gently sloping	15	18	27	35	18	22			1.0	1.4
Belfield-Rhoades silty clay loams, level	17	20	30	39	21	26			1.2	1.5
Belfield-Rhoades silty clay loams, gently sloping	15	18	27	35	18	22			1.0	1.5
Chama-Bainville loams, sloping	12	17	19	27	20	25	2.0	2.1	0.9	1.2
Chama-Bainville loams, strongly sloping	10	15	23	31	17	22			0.8	1.2
Cherry silty clay loam, gently sloping	18	24	40	49	30	35	3.6	3.9	1.2	1.5
Cherry silty clay loam, sloping	16	22	37	45	28	33	3.3	3.6	1.1	1.4
Colvin silt loam										
Dimmick clay		24		41		33				1.6
Eroded sandy land										
Farland silt loam, gently sloping	18	24	39	49	27	34	3.5	3.9	1.4	1.8
Farland silt loam, sloping	16	21	36	46	25	32	3.1	3.6	1.2	1.7
Farland, Arnegard and Grail silt loams, level	21	28	43	54	31	37	3.9	4.4	1.5	2.1
Flasher sandy loam, sloping										
Flasher complex										
Flasher-Rock outcrop complex										
Gallatin clay loam									1.3	2.5
Glendive fine sandy loam	19	25	33	43	24	29	3.8	4.1	1.4	1.9
Grail silty clay loam, level	23	29	45	56	33	39	4.4	4.9	1.5	2.2
Grail silty clay loam, gently sloping	21	27	42	52	31	37	4.1	4.6	1.3	2.0
Grail silty clay loam, sloping	18	24	40	49	30	34	3.6	3.9	1.2	1.8
Grail soils, saline										
Grail-Rhoades silty clay loams, level	17	20	31	39	20	24			1.3	1.6
Grail-Rhoades silty clay loams, gently sloping	15	18	28	36	18	23			1.1	1.4
Gravelly land										
Havre loam	21	27	43	54	31	37	3.9	4.3	1.5	2.0
Havre silty clay loam	20	25	38	46	29	35	3.1	3.4	1.3	1.7
Hoven soils		21		38		29				1.4
Lefor fine sandy loam, undulating	16	22	30	37	22	27	3.1	3.5	1.0	1.6
Lefor fine sandy loam, undulating, eroded	14	20	27	35	19	25	2.8	3.3	0.9	1.5
Lefor fine sandy loam, sloping	13	19	22	28	17	24	2.6	3.1	0.9	1.4
Lefor fine sandy loam, sloping, eroded	11	17	20	27	15	22	2.0	3.0	0.9	1.3
Lihen loamy fine sand, undulating	12	17	21	29	16	20	1.9	2.8	1.0	1.4
Lihen-Flasher loamy fine sands, rolling										
Little Horn and Duncom soils, level	19	25	33	45	26	32	3.0	3.4	1.2	1.6
Little Horn and Duncom soils, gently sloping	17	23	30	42	23	29	2.8	3.2	1.1	1.5
Manning loam, level	21	27	43	55	31	37	3.9	4.3	1.5	2.0
Manning fine sandy loam, level	18	23	31	37	22	28	3.1	3.4	1.2	1.5
Manning fine sandy loam, gently sloping	17	22	29	36	20	27	2.9	3.3	1.1	1.3
Manning fine sandy loam, sloping	14	19	21	27	18	23	2.8	3.1	0.8	1.2
Mine dumps										
Moreau silty clay, level	16	22	28	38	20	24	1.9	2.2	1.3	1.5
Moreau silty clay, gently sloping	14	20	25	35	18	22	1.6	1.9	1.1	1.3
Moreau silty clay, sloping	12	17	23	32	15	19			0.8	1.1
Moreau stony soils										
Moreau-Midway silty clays, strongly sloping										
Moreau-Rock outcrop complex										
Moreau-Midway-Rock outcrop complex										
Morton stony loam										
Morton-Bainville complex, strongly sloping	13	20	29	38	19	28			0.9	1.3
Morton-Chama clay loams, sloping	17	23	34	45	26	32	2.4	3.1	1.1	1.5
Morton-Chama silt loams, sloping	17	23	34	44	25	31	2.5	3.3	1.1	1.5
Morton-Chama silt loams, sloping, eroded	16	23	32	42	23	30	2.3	3.2	1.1	1.5
Morton and Farland clay loams, gently sloping	19	26	37	50	29	36	2.7	3.3	1.5	1.9
Morton and Farland clay loams, level	21	27	42	53	30	37	3.3	3.7	1.5	2.0
Morton and Farland silt loams, level	21	28	43	54	31	37	3.7	4.3	1.5	2.1
Morton and Farland silt loams, gently sloping	18	24	39	49	28	34	3.5	3.9	1.4	1.9
Morton-Rhoades, loams, level	17	20	31	39	21	25	2.3	2.6	1.3	1.6

See footnote at end of table.

TABLE 2.—*Estimated average acre yields of the principal crops grown under two levels of management*—Continued

Soil	Wheat		Oats [1]		Barley [1]		Corn (fodder)		Alfalfa	
	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*
Morton-Rhoades loams, gently sloping	15	19	29	37	19	24	2. 2	2. 6	1. 3	1. 6
Morton-Rhoades loams, sloping	11	16	25	29	15	20	------	------	1. 1	1. 4
Morton-Rhoades loams, sloping, eroded	9	15	23	28	13	18	------	------	0. 9	1. 2
Parshall fine sandy loam, level	18	23	32	41	22	26	3. 7	4. 1	1. 1	1. 6
Promise silty clay, level	20	26	39	48	29	35	3. 3	3. 7	1. 1	1. 6
Promise silty clay, gently sloping	19	24	36	44	27	32	3. 0	3. 4	1. 0	1. 6
Regent silty clay loam, level	21	26	37	46	28	34	3. 2	3. 9	1. 2	1. 7
Regent silty clay loam, gently sloping	19	23	33	43	26	31	3. 0	3. 4	1. 0	1. 6
Regent-Moreau silty clay loams, level	16	20	31	38	19	24	2. 2	2. 5	1. 2	1. 6
Regent-Moreau silty clay loams, gently sloping	14	19	29	36	17	22	2. 1	2. 5	1. 1	1. 5
Regent-Moreau silty clay loams, sloping	11	18	24	31	16	21	1. 9	2. 4	0. 9	1. 2
Rhoades and Belfield soils, level	------	------	------	------	------	------	------	------	------	------
Rhoades and Belfield soils, gently sloping	------	------	------	------	------	------	------	------	------	------
Saline alluvial land	------	------	------	------	------	------	------	------	------	------
Savage silty clay loam	20	26	40	49	29	36	3. 3	3. 6	1. 2	1. 7
Savage-Rhoades silty clay loams, level	17	20	29	39	21	24	2. 2	2. 5	1. 0	1. 4
Searing loam	17	22	31	36	21	27	3. 1	3. 4	1. 0	1. 3
Shale outcrop-Bainville complex	------	------	------	------	------	------	------	------	------	------
Shale outcrop	------	------	------	------	------	------	------	------	------	------
Straw loam, level	21	28	42	54	31	37	3. 9	4. 4	1. 5	2. 0
Straw and Havre soils, channeled	------	------	------	------	------	------	------	------	------	------
Valentine fine sand, hilly	------	------	------	------	------	------	------	------	------	------
Vebar-Flasher fine sandy loams, strongly sloping	11	16	19	28	16	21	2. 6	2. 9	0. 8	1. 1
Vebar-Manning fine sandy loams, sloping	10	15	18	25	15	20	2. 2	2. 6	0. 7	1. 0
Vebar-Parshall fine sandy loams, undulating	17	22	29	40	21	26	3. 6	3. 9	1. 0	1. 5
Vebar-Parshall fine sandy loams, sloping	15	18	22	31	18	23	2. 8	3. 2	1. 0	1. 4
Wet alluvial land	------	------	------	------	------	------	------	------	------	------
Wibaux soils	------	------	------	------	------	------	------	------	------	------

[1] Figures for yields of barley and oats should be reduced 20 percent if these crops are grown on soils that were not fallowed the previous year.

intermediate wheatgrass, bromegrass, tall wheatgrass, big bluestem, reed canarygrass, and switchgrass are suited to the somewhat poorly drained or poorly drained soils, and tall wheatgrass, western wheatgrass and slender wheatgrass are suited to the salty soils.

The Straw and Havre soils of capability unit VIe–Si are located along intermittent drainageways and have been dissected by drainageways. Those soils are flooded periodically, but the flooding is generally of short duration. Because of the periodic flooding and the size and shape of the areas, these soils are unsuitable for cultivation, but the additional moisture makes them suitable for grasses and legumes. Therefore, some areas are suitable for pasture and tame hay. Bromegrass and alfalfa are the species commonly used for seeding these Straw and Havre soils.

Use of the Soils for Range

Approximately 37 percent of the total land area in Stark County is in range. The soils in range are mainly ones that are not suitable for cultivated crops. Although some of the areas now in grass were formerly plowed and farmed for a time, the farmers soon learned that some of the soils are not suited to cultivated crops. They discontinued cultivation after a few years, and then, the kinds of plants that were in the original cover became reestablished. The land that was formerly used for crops is now generally termed "go-back" land. Most of the land that was formerly cultivated was abandoned for cultivation during the thirties. Some of the fields that were formerly used for crops now appear to be much like the surrounding areas of range that have not been plowed. Others can be distinguished easily because of differences in the vegetation.

As a rule, the only soils in grass that were not cultivated were the steep or stony soils or soils severely limited by a claypan, by extremely coarse texture, or by some other obvious characteristic that made them undesirable for farming. The resulting pattern of areas of grassland, therefore, is one which largely conforms to the general relief. Most areas of range are in the breaks that extend outward from the Heart, Knife, and Green Rivers. Smaller patches consist of areas of loose sand or sandstone ridges, knobs where scoria is at or near the surface, and flats where the soils contain a claypan. In a few places there are small, irregularly shaped patches of soils suitable for cultivation within the areas of soils not suitable for crops. The soils in these small patches escaped cultivation, mainly because they were not readily accessible, or because the landowner wished to block out a pasture where most of the tract was unsuitable for cultivation.

Most of the grassland in the county is used for grazing, except for small areas that receive additional moisture from runoff. Those areas are often mowed for hay. On some farms where the tracts in native grass are small and are surrounded by land used for other purposes, these small areas are used as a habitat for wildlife. Some income is derived from ranching or livestock farming on

approximately 85 percent of the farm and ranch units in the county, and the raising of livestock is a major enterprise on about 60 percent. Producing beef cattle for the feeder market is by far the most important livestock enterprise. Most of the livestock are sold through local auction markets. Cattle produced for the feeder market are sold mainly as weaner calves. In 1959 about 65 percent of the total agricultural income was derived from the sale of livestock and livestock products.

Range sites and condition classes

The basic unit used to describe areas of native pasture is the range site. Range sites are distinctive kinds of rangeland that have different potential for producing native plants. Each range site has its own combination of environmental factors that result in the plant community found only on that site. The range site retains its ability to produce this potential plant community, unless it is altered by overgrazing. The grass in nearly level or gently sloping areas is usually grazed more intensely than that on steep or sloping soils. The range site, therefore, generally deteriorates faster in condition and productivity in nearly level or gently sloping areas than in steeper ones.

The condition of the native pasture is determined by comparing the present vegetation with the *climax vegetation*, that is, with the type and combination of plants that originally grew on the site before the area was disturbed by overgrazing. As a rule, the climax vegetation is the most productive combination of native plants that will grow on a site.

The range site may not have the best adapted native plants growing on it, because livestock select the larger or more palatable plants. If grazing is not carefully controlled, the better plants are eventually eliminated. The most palatable plants, called *decreasers*, are the first to be eliminated under heavy grazing. Less desirable, smaller or second-choice plants increase as the decreasers die out, and these plants are called *increasers*. If heavy grazing continues, even the second-choice plants will be thinned out or eliminated, and undesirable weeds, or *invaders*, take over the site.

Four range condition classes have been defined and are commonly used in appraising the condition of the range. These are based on the percentage of the present range vegetation made up of climax species. A range in excellent condition has from 76 to 100 percent of the vegetation that is characteristic of the climax vegetation on the same site; one in good condition, 51 to 75 percent; one in fair condition, 26 to 50 percent; and one in poor condition, less than 26 percent.

Descriptions of range sites

Sixteen range sites make up the rangeland in Stark County. On the basis of their contribution to the amount of available forage, these have been divided into two categories—sites of major importance, and sites of minor importance. The Thin Silty, Panspot, Silty, Thin Sandy, Clayey, and Sandy range sites are the major ones in the county. Minor sites are the Sands, Choppy Sands, Overflow, Wetland, Subirrigated, Shallow to Gravel, Saline Subirrigated, Thin Breaks, Very Shallow, and Badlands. Some of these minor sites were formerly important, but now most of the original acreage has been plowed and planted to cultivated crops. Other sites never occupied a large acreage in the county, but may be important on an individual farm or ranch. All of the soils in the county have been included in a range site.

The range sites in the county are described in the following pages. In each description are pointed out some of the ways the soils influence the growth of plants on the site. Also briefly described is the plant community that represents the potential for the site. The range sites are discussed in the decreasing order of the total annual yield for the site. Clipping and weighing to determine the exact yields have not been done on all the sites, however, and the yield figures are estimated.

The yield figures given are for the air-dry weight of all of the herbaceous part of the plant above ground on range in excellent condition. The figures also include the weight of new growth of woody plants. The high figure and low figure given for yields are intended to reflect the normal fluctuations in yearly precipitation. The figures given do not indicate the amount of forage that may be removed by grazing or cutting for hay if the range is to be maintained in good condition.

WETLAND RANGE SITE

In this range site are somewhat marshy subirrigated soils. Seepage or ponding keeps the water table above the surface for part of the growing season.

Tall-growing species make up almost all of the plant cover on this site. Grasses and sedges are predominant, but a few tall forbs make up part of the stand late in the season. The grasses and sedges grow mainly in patches having a fairly pure stand, instead of in a more uniformly mixed stand, as on most range sites. The primary plants when this site is in excellent condition are prairie cordgrass, Northern reedgrass, river grass, and smartweeds. Secondary plants are American mannagrass, wetland sedges, prairie wedgescale, common spikerush, Baltic rush, Mexican dock, tall white-aster, and Rydbergs sunflower.

The cover of plants on this site varies in composition from place to place, depending on the degree of wetness, frequency of flooding, and similar factors. It changes somewhat also when abnormally dry or wet cycles extend over a period of years. The estimated annual yield of air-dry herbage on this site in excellent condition is 4,500 to 6,000 pounds per acre.

Because the soils are wet, this range site is normally most suitable for late-season grazing. It can also be grazed throughout the summer, however, and the plants remain palatable for cattle and horses. This is because, though the forage plants are large and coarse, they generally receive enough moisture that they do not become dry and tough. This range site can be managed more effectively if it is separated from other areas of range. Therefore, if the acreage is large enough to justify the expenditure, the site should be fenced and managed separately.

SUBIRRIGATED RANGE SITE

The soils in this range site are mostly on flat bottom lands, in imperfectly drained swales, or at the base of long, smooth slopes. Water rarely stands on the surface during the growing season, but the water table is near enough to the surface to influence the kind of vegetation and the amount of forage produced.

This range site presents a rather lush meadow appearance. The vegetation consists largely of tall-growing species; a large part of it is forbs, and these are conspicuous late in summer. Heavy grazing of this site causes the formation of small humps and depressions. The common primary plants when this site is in excellent condition are switchgrass, big bluestem, little bluestem, tall species of sunflower, goldenrod, cinquefoil, moderately tall wetland sedges, and prairie wedgescale. Secondary plants are matmuhly, tall dropseed, Macoun wildrye, wild mint, and milkweed.

The cover of plants on this site varies considerably in composition, depending on such factors as the level of the water table, the content of lime in the soils, and the presence of salts. The estimated annual yield of air-dry herbage on this site in excellent condition is 4,000 to 4,800 pounds per acre.

Most of the important forage plants on this site make their fastest growth and development during the warm summer months. This and the consistently abundant supply of water make the forage palatable to livestock throughout most of the growing season. The site is, therefore, most suitable for grazing in summer and fall. In years when rainfall is excessive, heavy grazing during the early part of the season often leads to damage from trampling.

This site can be managed more efficiently if it is fenced to separate it from drier range sites. If the acreage is large enough to justify separate management, the site should be managed separately.

SALINE SUBIRRIGATED RANGE SITE

A nearly level land type in which there are accumulations of salts or alkali, or of both salts and alkali, makes up this range site. The areas are mainly on bottom lands or in swales or slightly concave drainageways. The water table is high because seepage water is received from higher areas.

Most of the vegetation on this site consists of plants that tolerate salt. The primary plants are Nuttall alkaligrass, inland saltgrass, and Pursh seepweed. Secondary plants are western wheatgrass, slender wheatgrass, plains bluegrass, alkali plantain, alkali cordgrass, prairie bulrush, and silverweed cinquefoil. As a result of differences in the degree of salinity or wetness, the plant cover is not uniform throughout the site. Abrupt changes in the type of vegetation occur from one area to another. Salt-tolerant mid grasses are most conspicuous in the plant cover, and of these, Nuttall alkaligrass is generally predominant. In some spots, however, the only vegetation is inland saltgrass. Other spots are practically bare, especially in dry years. In other years they have a cover of salt-tolerant annual forbs. The estimated annual yield of air-dry herbage on the site in excellent condition is 3,400 to 4,000 pounds per acre.

The soils of this range site are usually wettest early in the season. Therefore, the site should not be grazed at that time, because of the likelihood of damage from trampling. Stocking the range as soon as the soils have dried enough to receive livestock is advantageous, however, especially if stocking takes place before the main grasses are mature. The best time varies considerably because of differences in the wetness of the season.

Where this site occupies rather large areas, it is well to fence it. Then, the site can be managed separately from the adjacent range sites.

OVERFLOW RANGE SITE

In this range site are soils in flat-bottomed, shallow basins, where they regularly receive more than normal moisture through runoff from higher areas. The areas resemble a meadow.

The vegetation on this site is predominantly species of medium height, but the plants generally grow to more than normal height and form a dense stand. Tall-growing forbs are prevalent, and at times, they are conspicuous in the stand. Primary plants when this site is in excellent condition are green needlegrass, western wheatgrass, slender wheatgrass, Maximilian sunflower, American licorice, and milk vetch. Secondary plants are bearded wheatgrass, porcupinegrass, heath aster, tall dropseed, Canada wildrye, American vetch, and a number of minor forbs. Together the minor forbs make up a fairly large percentage of the total cover. The estimated annual yield of air-dry herbage on the site in excellent condition is 3,200 to 3,600 pounds per acre.

Because of the small extent and low position of the soils, this site is among the first to be damaged if livestock are concentrated on it and are allowed to overgraze. Management based on deferred grazing is important in keeping the site producing well, and the range should also be rested occasionally for an entire season. Controlling the distribution of livestock by placing salt at various places is often effective in managing this site. It keeps livestock from concentrating and overgrazing any one area.

SANDS RANGE SITE

Deep, loose fine sands, very fine sands, and loamy fine sands are in this range site. The soils are nearly level or undulating.

The plant cover on this site is made up mainly of the taller pasture plants. The stand is rather thin when the site is in climax condition, and forbs generally make up a large part of the cover. In most places bare spots can be seen between the plants, except in the patches of prairie sandreed, which are dense. A fairly uniform understory of sun sedge is common, and there are some woody plants. Primary plants when the site is in excellent condition are prairie sandreed, needle-and-thread, and sun sedge. Secondary plants are Canada wildrye, threadleaf sedge, wilcox panicum, and leadplant amorpha. A large number of minor forbs are common on this site, and collectively, these make up a large part of the forage weight. The plant cover includes a few woody plants.

A large amount of forage is produced on areas of this range site that are in the uplands. Most of the vegetation is coarse, however, and as a result, patchy grazing is likely to become a problem. The patchy grazing can be overcome by concentrating livestock more heavily on a small part of the range for a short period. It is important to properly stock the range because this site is highly susceptible to damage from overgrazing.

The sandy soils of this range site are more suitable for older age cattle, especially for cows and calves run together, than for other kinds of livestock. The more selective grazing habits of sheep and horses are likely to

lead to such close grazing in spots that wind erosion may get started. The production of range forage is good on the upland areas of the site, but most of the vegetation is coarse.

CHOPPY SANDS RANGE SITE

Deep, loose fine sands on abrupt, irregular slopes are in this range site. The areas contain narrow ridges and peaks, and there are also depressions and blowouts. In many places the surface is broken, and in those areas erosion is active. The small acreage of this range site in Stark County, however, is relatively smooth for this range site.

In many places woody plants are an important part of the vegetation on this site, and they give the range a rather brushy appearance. A number of deep-rooted forbs is also common. Most of the grasses are tall. The stand is generally thin as compared with the cover on finer textured soils, and some bare spots are evident in most places.

The primary plants on this site in excellent condition are sand bluestem, prairie sandreed, needle-and-thread, sand dropseed, and a number of decreaser forbs. Secondary plants are Canada wildrye, little bluestem, and sun sedge, prairie spiderwort, lemon scurfpea, fringed sagewort, leadplant amorpha, western snowberry, and other minor forbs and woody plants. The estimated annual yield of air-dry herbage on the site in excellent condition is 2,200 to 3,000 pounds per acre.

In extensive areas of this range site, the soils are highly susceptible to erosion if they are improperly grazed. Many of the areas are not grazed, however, and therefore, problems connected with the site are negligible.

SANDY RANGE SITE

In this range site are deep and moderately deep fine sandy loams. Also included are dark-colored, nearly level loamy fine sands.

Mid grasses are generally predominant and contribute most to the general appearance of the site during most seasons of the year. Conspicuous patches of prairie sandreed are common. They consist largely of a pure stand of prairie sandreed with a light understory of sun sedge. Blue grama, dryland sedges, and a natural mulch of plant residue provide a nearly complete cover. A number of different kinds of forbs affects the general appearance of the site during certain seasons of the year.

Primary plants when this site is in excellent condition are needle-and-thread, prairie sandreed, threadleaf sedge, and forbs. Secondary plants are western wheatgrass, blue grama, sun sedge, little bluestem, silverleaf scurfpea, western yarrow, cudweed, sagewort, prairie spiderwort, and other minor forbs. The estimated annual yield of air-dry herbage on the site in excellent condition is 1,600 to 2,400 pounds per acre.

This site lends itself well to proper grazing management. Good distribution of grazing is fairly easy to attain if the range has an adequate number of watering places and if the water is well distributed. The most important forage plants include both plants that grow well in cool seasons and plants that grow well in warm seasons. As a result, grazing is good throughout a large part of the growing season. Stocking the range at a proper rate is the most important management principle involved.

SILTY RANGE SITE

This range site is mainly in the intermediate zone between the lowland and the hills. In it are all the deep and moderately deep very fine sandy loams, loams, silt loams, and silty clay loams of the county. The plant cover on the site is uniformly mixed. No single species is dominant, as a rule, although western wheatgrass and needle-and-thread generally make up a large part of the cover in most areas. Forbs are prevalent in low spots and in other areas that receive additional moisture. Many of the minor forbs blossom late in May and in June. In some years they give a flowery appearance to the range.

The primary plants that are common when this site is in excellent condition are western wheatgrass (fig. 16), needle-and-thread, blue grama, and forb decreasers. Secondary plants are green needlegrass, prairie junegrass, plains reedgrass, heath aster, western yarrow, cudweed, sagewort, milk vetch, and other minor forbs. The estimated annual yield of air-dry herbage on the site in excellent condition is 1,500 to 2,000 pounds per acre.

For the most part, this range site is rather smooth. Therefore, management is generally not difficult where watering facilities are available. The most important

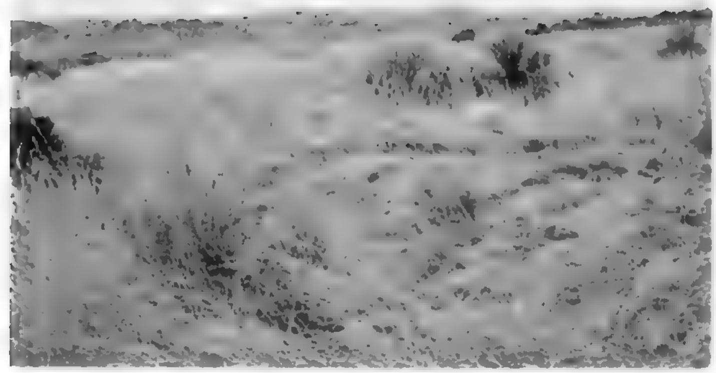

***Figure 16.*—In the upper picture is an area of the Silty range site that has not been grazed, because it is not accessible. In this area the range site is in excellent condition; lodged thickspike wheatgrass is in the foreground, and erect western wheatgrass is in the immediate background. In the lower picture is shown another area of the Silty range site that has been grazed for 75 years. Short grasses, primarily blue grama, have increased as a result of the sustained close grazing. The soils are the same as those shown in the upper picture, but only about half the amount of forage is produced on the site in the lower picture.**

range plants on the site develop mainly while the weather is cool in spring and early in summer. Managers of range, however, should not allow grazing too early on their summer pastures, at least as a regular practice.

CLAYEY RANGE SITE

All of the fairly pervious silty clay loams and silty clays in the county are in this range site. The plant cover is nearly uniform throughout the upland areas of the site. Western wheatgrass is the most common kind of plant in the stand. It dominates the general appearance of the site. Green needlegrass is abundant in many of the swales and minor depressions, and it appears to be dominant in those areas. Forbs are generally not abundant on this site, and most of the more common species that grow on the site are low growing.

Primary plants that commonly grow on this site when the range is in excellent condition are western wheatgrass, green needlegrass, and blue grama. Secondary plants are plains reedgrass and needleleaf sedge; and wild parsley, prairie thermopsis, Hoods phlox, scarlet globemallow, milk vetch, prairie coneflower, and other minor forbs. The estimated annual yield of air-dry herbage on the site in excellent condition is 1,500 to 2,000 pounds per acre.

This range site ought to be managed with special care to keep it in good condition. If grazing pressure is severe, short grasses and dryland sedges are likely to increase rapidly in the plant cover. As a result, runoff speeds up in these rather tight soils and erosion is more of a hazard than in the coarser textured soils. The high water-holding capacity of the clay soils causes the site to remain wet until late in spring. Protection from grazing is needed when the soils are wet.

THIN SILTY RANGE SITE

This range site consists of shallow, silty soils of hills and streambanks. The soils have smooth slopes that are generally steeper than 12 percent.

The primary plants when this site is in excellent condition are little bluestem, plains muhly, sideoats grama, stiff sunflower, blacksamson echinacea, purple prairie-clover, and needle-and-thread. Secondary plants are porcupinegrass, western wheatgrass, white penstemon, plains reedgrass, spreading pasqueflower, cudweed, sagewort, dwarfindigo amorpha, and western snowberry.

Little bluestem, a reddish-colored bunch grass, is generally most conspicuous on the upper slopes and ridgetops in this range site. It grows in a nearly pure stand in some places. Needle-and-thread and porcupinegrass are generally dominant on the lower slopes. Forbs are common on both the upper and lower slopes, but the species vary, to a considerable extent, according to the position on the slope. Woody plants generally grow on the lower slopes and in the swales. The estimated annual yield of air-dry herbage on this site in excellent condition is 1,400 to 1,800 pounds per acre.

Distributing grazing well throughout this hilly range site is likely to be a problem. This is especially true where the grazed areas include some smoother areas. Facilities for providing water need to be spaced closer together than in more open areas of range. Building cross fences to separate this site from others is a help in distributing grazing. Also, fencing small areas of range so that those areas can be grazed for short periods at a higher stocking rate helps in obtaining more uniform use of the range.

SHALLOW TO GRAVEL RANGE SITE

Only Gravelly land is in this range site. It consists mainly of a thin layer of loam or sandy loam underlain by loamy gravelly or cobbly material. The effective depth of this soil material, that is, the depth to which roots can penetrate easily and procure plant nutrients and moisture, is 10 to 20 inches.

As a rule, needle-and-thread is by far the predominant vegetation on this site, and it contributes the most to the general appearance of the site during all seasons of the year. In some places drought-tolerant forbs and short grasses are dominant, however, in the spots where there is only a small amount of soil material, mostly on the crests of ridges and knolls. The proportion of forbs is low compared to that on sites where the soils are deeper. An understory of short grasses and sedges generally covers the entire site, and as a result, the plant cover has a fairly high density.

In addition to needle-and-thread, the primary plants when this site is in excellent condition are blue grama and threadleaf sedge. Secondary plants are western wheatgrass, prairie junegrass, needleleaf sedge, red threeawn, scarlet globemallow, fringed sagewort, Hoods phlox, Rush skeletonplant, broom snakeweed, woolly goldenrod, dotted gayfeather, and other minor forbs. The estimated annual yield of air-dry herbage on this site in excellent condition is 1,300 to 1,700 pounds per acre.

Droughtiness is a major factor that affects this site. If continued heavy grazing is allowed, the condition of the range deteriorates within a few years. This deterioration is usually marked by a decided increase in the amount of fringed sagewort in the stand. This site is generally along the edges of flats adjacent to streams where grazing pressure is the heaviest. The acreage in any one place is normally too small, however, for deterioration of the range to be especially significant. Occasionally, resting the pasture for an entire growing season helps to keep the site in good condition. Once the site has deteriorated, however, improvement is usually slow.

THIN SANDY RANGE SITE

Moderately sandy soils that do not have a well-developed profile are in this range site. These soils generally are in hilly areas and have smooth slopes.

The cover of plants on this range site varies considerably from place to place. Primary species when this site is in excellent condition are little bluestem, plains muhly, prairie sandreed, needle-and-thread, stiff sunflower, blacksamson echinacea, and dotted gayfeather. Among the main secondary plants are porcupinegrass, threadleaf sedge, sun sedge, western wheatgrass, prairie-clover, and penstemon. Needle-and-thread and little bluestem are generally predominant. The plant cover on most hilltops, however, is mainly threadleaf sedge and plains muhly. Forbs are generally not abundant, but the stand includes a few species of woody plants near areas of sandstone outcrops.

The estimated annual yield of air-dry herbage on this site in excellent condition is 1,200 to 1,800 pounds per acre.

Like the Thin Silty range site, this range site is hilly. Management is about the same as that described under the Thin Silty range site.

PANSPOT RANGE SITE

In this range site are soils in which hard clay or other nearly impervious material is close to the surface or is at the surface. Areas of these soils contain shallow depressions that occupy 20 to 50 percent of the acreage in the site.

The soils of this range site are not uniform in characteristics, and as a result, the plant cover has a spotty appearance. Where the soil material is shallow over impervious material, the mid grasses grow less vigorously than where the soil material is deeper. In some of these areas of shallow soil material, short grasses are dominant. Some forbs are adapted to this site, but forbs do not make up an important part of the plant cover in most places. Where the impervious material is at the surface, many areas that are bare except for tumblegrass occur. During the wetter seasons, they are covered with annual broadleaf weeds.

The primary plants when this site is in excellent condition are western wheatgrass, needle-and-thread, and blue grama. Inland saltgrass also is abundant in some areas. Secondary plants are green needlegrass, prairie junegrass, needleleaf sedge, buffalograss, sandberg bluegrass, broom snakeweed, scarlet globemallow, Hoods phlox, and plains pricklypear. Mid grasses are dominant on most of the range site. The estimated annual yield of air-dry herbage on this site in excellent condition is 1,200 to 1,800 pounds per acre.

Managers of rangeland need to be especially careful about properly stocking this range site. If the site is overgrazed, blue grama and buffalograss drastically increase and the vigor of the midgrasses is greatly reduced. Also, fringed sagewort is likely to increase to serious proportions, and as a result, the yield of desirable range plants becomes very low.

Where the range has deteriorated, mechanical disturbance is sometimes used to speed up improvement. If desirable results are to be obtained, the range must always be rested after the surface has been disturbed.

THIN BREAKS RANGE SITE

In this range site are mixed soils that vary in depth and in kind of underlying material. The underlying material crops out at different levels, and as a result, the slopes are irregular and range from 20 to 65 percent. Typically, the slopes are 300 to 600 feet long. They are fairly smooth, but hard rock crops out in places. The outcrops are not prominent.

The cover of vegetation is rather thin, and there are bare spots in many places where the underlying material crops out. Bunch grasses and woody plants are prevalent on the slopes that face north and east. This results in a rather open stand.

The primary plants when this site is in excellent condition are little bluestem, plains muhly, needle-and-thread, porcupinegrass, stiff sunflower, purple prairie-clover, and blacksamson echinacea. Sideoats grama, thickspike wheatgrass, and plains reedgrass are prevalent in most areas of the finer textured soils. Scattered larger shrubs and small trees are common on the breaks. The estimated annual yield of air-dry herbage on this site in excellent condition is 1,200 to 1,800 pounds per acre.

Distributing livestock properly is a major problem in managing this range site. Livestock tend to concentrate in the swales, on the lower slopes, and in other smooth areas within the site. As a result, those areas are likely to be overgrazed before much use is made of the forage on the upper slopes and plateaus. The problem is especially acute where cows and calves are grazed together, but yearling cattle and horses distribute themselves much more satisfactorily over the range. All kinds of livestock tend to distribute themselves better after the hot part of summer and after the season when flies are the most prevalent is past. Dividing the range by building cross fences to permit deferred grazing on a rotational schedule promotes more uniform use of this type of range. The low potential yields, however, do not justify a large expenditure for development costs.

VERY SHALLOW RANGE SITE

In this range site bedrock or scoria crops out in many places. In only a few areas can roots penetrate to a depth greater than 10 inches.

Mid grasses make up a considerable proportion of the climax vegetation on the site, although the soils are droughty. These grasses do not grow as vigorously, however, as the mid grasses on deeper soils. Short grasses and sedges normally make up a fairly large part of the cover, and as a result, the stand is fairly dense. A fairly large proportion of the plant cover also consists of shrubs that tolerate drought, and there are a few woody plants. The woody plants grow in areas where the bedrock is fractured and soil material has accumulated in the cracks between the rocks.

The primary plants when this site is in excellent condition are needle-and-thread, blue grama, threadleaf sedge, red three-awn, and such forbs as broom snakeweed, fringed sagewort, ironplant goldenweed, Hoods phlox, and scarlet globemallow. Secondary plants are needleleaf sedge, plains muhly, western wheatgrass, common winterfat, creeping juniper, and plains prickleypear. The estimated annual yield of air-dry herbage on this site in excellent condition is 500 to 800 pounds per acre.

This range site occupies only small areas that are scattered throughout the Thin Breaks range site. Its use for grazing fits in well with that of the surrounding Thin Breaks site, and no special problems are encountered in managing it.

BADLANDS RANGE SITE

In this range site are nearly bare areas broken by drainageways that are dry most of the year. Intermingled with the bare areas are grassed areas that could be grazed but that are too small to be used and managed separately. Long, steep, eroding slopes are typical of this site and give the site its characteristic appearance. The grassed areas contain areas of shallow soils that have a texture of loam to silty clay loam.

The vegetation varies as a result of differences in the characteristics of the soils and in the exposure. In most places, even in the most favorable spots, however, the cover of plants is thin and a large part of it consists of woody plants. A few species of forbs are common both within the areas where woody plants are predominant and outside the areas.

The primary plants when this site is in excellent condition are little bluestem, plains muhly, needle-and-thread, thickspike wheatgrass, stiff sunflower, and purple prairie-clover. Threeleaf sedge, and prairie sandreed are abundant on the sandy soils, and inland saltgrass is prevalent in some areas. Canada wildrye, slender wheatgrass, and big bluestem grow extensively near the thicketed areas. Secondary plants are red three-awn, western wheatgrass, sand dropseed, Gardner saltbush, greenplume rabbitbrush, longleaf sagebrush, broom snakeweed, plains reedgrass, narrowleaf penstemon, and bearberry. Green ash, Rocky Mountain juniper, common chokecherry, and skunkbush sumac are the most common small trees and shrubs. The estimated annual yield of air-dry herbage on this site in excellent condition is 400 to 700 pounds per acre.

This range site contains a larger number of bare or nearly bare areas of various sizes than the Thin Breaks range site. As a result, the average amount of forage produced per acre is smaller than that produced on the Thin Breaks range site, and the stocking rate must be kept lower. In other respects, grazing management is about the same as that discussed for the Thin Breaks range site.

Use of the Soils for Windbreaks [1]

Most of the trees grown in this county have been planted to protect farmsteads and fields from wind. The only native woodland is on bottom lands along the main streams and in a few patches on the north side of the higher bluffs. Practically no evergreens grow naturally in this county. The native woodland has little commercial value for wood products, but some fenceposts and wood for fuel are cut. The woodland does have great value as a shelter for farmsteads. It also provides shelter for livestock and wildlife, and it protects from erosion the streambanks and the soils in the watershed. The main trees in the native woodland are green ash, American elm, and boxelder, but there is an occasional cottonwood or aspen. Mixed with the native trees are stands of plum, chokecherry, buffaloberry, juneberry, wolfberry, and other shrubs. These provide cover and food for wildlife.

Farmstead windbreaks.—Most farmsteads in the county are protected by some kind of windbreak. Most of the windbreaks are on the north and west sides of the farmstead and feedlots. Few are on the south and east sides. Some protection from drifting snow is advisable on the south and east, however, as one or two storms are from those directions each winter. Such protection is provided by shrubs or evergreens and is well worth the cost.

Field windbreaks.—These have a definite place in parts of the county. In addition to helping to control wind erosion, a good field windbreak increases the supply of moisture in the soil by holding snow on the fields. It also protects crops from damage from strong winds, reduces the amount of evaporation and transpiration that takes place in the adjoining fields, and supplies food and cover for wildlife (fig. 17). Field windbreaks are especially needed on the soils in capability units IIIe–3, IIIe–3M, IVe–2, and IVe–3.

Plantings for wildlife.—This type of windbreak is made mainly to provide food and cover for upland game birds

[1] By ELMER L. WORTHINGTON, woodland conservationist, SCS, Bismarck, N. Dak.

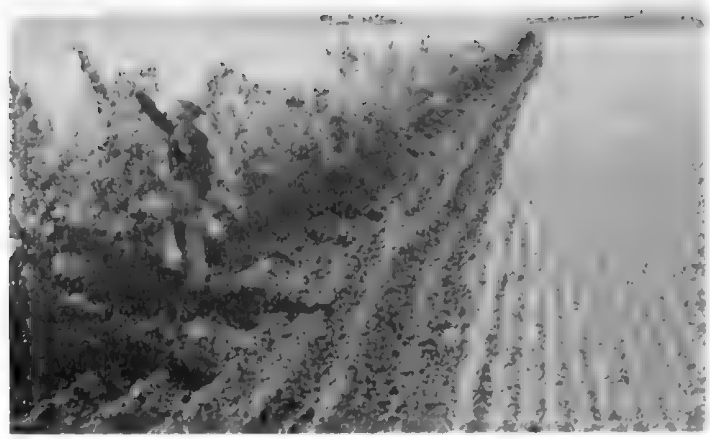

***Figure 17.*—Four-year-old windbreak of Siberian elm planted to protect the soils in a field of Vebar-Parshall fine sandy loams. The trees have been planted in single rows, 20 to 40 rods apart, to reduce the surface velocity of the wind.**

and animals. Normally, this type of windbreak is short and wide—generally only about 1,000 feet long and 200 to 225 feet wide. It contains many rows of shrubs of various kinds, taller trees, and a few rows of evergreens. The windbreak is designed so that part of it is always free of drifting snow.

Preparation and maintenance of the windbreak site.—Proper preparation of the site is essential before the windbreak is planted if the trees are to survive and grow. The area in which the trees and shrubs are to be planted must be free of grass and perennial weeds. The best preparation before planting a windbreak is to clean summer fallow the year before the windbreak is planted. However, planting a windbreak along the edge of a field that has been used for row crops the previous year is generally satisfactory. In a few sandy areas, the trees or shrubs may be planted in clean stubble, because the soils would be subject to severe wind erosion if they were fallowed or used for row crops. It is often necessary or desirable on such sandy soils to plant a cover crop between the rows late in summer so that the young windbreak will be protected from sandblasting. A field that is in alfalfa or perennial grass should be fallowed for 2 full years before the planting is made.

If the weather has been dry in spring, it may be necessary to water the young trees after they are planted. Also, where feasible, it may be necessary to divert runoff water, so that the trees receive extra moisture from the surrounding areas.

Clean cultivation for the entire life of the windbreak is highly desirable. Cultivation ought to be frequent enough so that competitive grasses and weeds are controlled.

Suitability for windbreaks.—Many soils in this county are not suitable for windbreaks; some are too saline, shallow, droughty, or steep. In the section "Descriptions of the Soils," each mapping unit is given a rating of *excellent*, *good*, or *fair*, according to suitability for growing trees, and lack of suitability is indicated. A rating of *excellent* means that the available moisture and soil char-

acteristics are optimum for the climate. A rating of *good* means that the trees or shrubs grow more slowly on soils with this rating than on soils rated as excellent. It also means that there are minor soil restrictions that influence the kinds of trees that are best suited to these soils. A rating of *fair* means that only certain species of trees can be grown on the soil. Also, droughtiness or other adverse characteristics affect the rate of growth and the mature height of the trees.

Most trees in this county have reached their mature height when they are 30 years of age, and most shrubs reach maturity in 20 years. On soils that are given a rating of *excellent* for trees, the main species, such as ash and Siberian elm, have a mature height of 35 to 42 feet at maturity. Cottonwood on sites that receive some runoff or extra moisture from the water table and that are rated excellent attain a height of 65 to 70 feet at maturity. Mature shrubs of honeysuckle and caragana are 9 to 12 feet high on sites rated as excellent.

On soils that are given a rating of *good*, the main species, such as ash and Siberian elm, have a mature height of 27 to 35 feet at maturity. Honeysuckle and caragana are 6 to 8 feet high when they reach maturity.

On the soils that are given a rating of *fair*, the main trees, such as ash and Siberian elm, have a mature height of 18 to 24 feet at maturity. Shrubs such as honeysuckle and caragana are 4 to 5 feet high at maturity.

Wildlife [2]

The kinds of wildlife in Stark County have changed since the area was settled. Bison, elk, wolves, and other species not compatible with ranching and farming are no longer present. In the following paragraphs, some of the main species of wildlife are discussed briefly and their general range, by soil associations, is indicated. A colored map in the back of the report shows the location of the soil associations in this county.

Sharp-tailed grouse.—The best habitat for this native game bird is in areas where a large part of the acreage is in range, and where shrubby thickets and small tracts of woods are well distributed. The grouse are mainly on the Rhoades, Promise, and Moreau soils of association 4; on the Bainville and Midway soils of association 8; and on the Bainville and Flasher soils of association 9.

Good production of grouse can be maintained by protecting the range from overgrazing, providing well-distributed shrub thickets within the breeding range, and planting or protecting large tracts of shrubs and of shrubs and trees so that they will be available for use in winter.

Pheasant.—This game bird is not native to North America, but it has been successfully introduced. Its range is limited to the areas where crops are grown, for pheasant depend on farm crops and on the associated weed seeds for food.

All of this county has high potential for producing pheasant, but the best farming areas have the highest potential. The best habitats are mainly the Morton, Regent, and Grail soils of association 1; the Morton, Vebar, and Arnegard soils of association 2; the Promise and Moreau soils of association 3; the Farland, Havre, and Parshall soils of association 6; and the Farland, Savage, and Rhoades soils of association 7.

Gray partridge (Hungarian).—This small game bird, like the pheasant, is not native to North America. Its requirements and range are similar to those of the pheasant. It prefers a somewhat more open site in cultivated areas, however, than the pheasant.

Antelope.—This animal has its habitat where the vegetation is mainly grass and sagebrush. The population of antelope is highest in areas where native forbs and browse are abundant, but legumes and sprouted and waste grain are a substitute for the forbs and browse. The principal needs of the antelope are adequate food and areas of rough land for wintering. Generally, enough food is available in areas of range if the range is properly used. The habitat of antelope in this county is mainly the Rhoades, Promise, and Moreau soils of association 4; the Belfield and Rhoades soils of association 5; and the Bainville and Midway soils of association 8.

Deer.—Both white-tailed and mule deer have their habitat in this county. The population of these animals is highest where areas of woods and shrubs are most abundant. Such tracts consist mainly of areas of rough broken land and of areas along streams. The deer are mainly on the Farland, Havre, and Parshall soils of association 6; on the Bainville and Midway soils of association 8; and on the Bainville and Flasher soils of association 9. Protecting tracts of woods and shrubs from damage by livestock is the most beneficial practice for improving the habitat for deer.

Water fowl.—The construction of farm ponds to provide water for livestock, mainly on the Rhoades, Promise, and Moreau soils of association 4, has brought about an increase in the number of waterfowl in this county. Ducks are the main kinds of waterfowl. Mallard, pintail, and blue-winged teal are the most numerous species. Occasionally, a wild goose is harvested with the ducks.

The production of waterfowl can be improved by constructing shallow impoundments for water and protecting the shoreline of ponds from trampling by livestock.

Fish.—Fisheries in this county are only in artificial impoundments. The only one of importance is Dickinson Reservoir, managed by the North Dakota Game and Fish Department. The number of privately managed fish ponds is limited. The potential for constructing farm ponds that are large enough and deep enough to support desirable kinds of fish is good. The edges of soil associations that border main drainageways have some desirable sites. Areas that appear to have desirable sites are the Rhoades, Promise, and Moreau soils of association 4; the Morton, Vebar, and Arnegard soils of association 2; and the Bainville and Midway soils of association 8.

Use of the Soils for Engineering

This section discusses the properties of the soils that pertain to engineering. This information, prepared mainly for engineers, can be used to—

1. Make soil and land use studies that will aid in selecting and developing sites for industries, businesses, residences, and recreational areas.
2. Make preliminary estimates of the engineering properties and runoff characteristics of the soils

[2] By E. B. Podoll, field biologist, SCS, Bismarck, N. Dak.

for use in designing dams, agricultural drainage systems, and other structures that protect the soils and that conserve and control water.

3. Make reconnaissance surveys of soil and ground conditions that will aid in selecting locations for highways and airfields and in planning detailed investigations at the selected locations.
4. Locate probable sources of sand and gravel for use in structures and as a base for both flexible and rigid pavements.
5. Correlate pavement performance with types of soil and thus develop information that will be useful in improving the design and maintenance of pavements.
6. Determine the suitability of soil mapping units for cross-country movement of vehicles and construction equipment.
7. Supplement information obtained from other published maps and reports and aerial photographs for the purpose of making soil maps and reports that can be readily used by engineers.
8. Create awareness of the hazards, limitations, and useful properties of soils to be used for highway and earth construction, where definite laboratory data are lacking or are not available.

The engineering interpretations reported here can be used for many purposes. It should be emphasized, however, that these interpretations may not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads and where the excavations are deeper than the depths of the layers here reported. Even in these situations, the soil map is useful for planning more detailed field investigations and for suggesting the kinds of problems that may be expected.

Some of the terms used by the soil scientist may be unfamiliar to the engineer, and some words, for example, *clay*, *silt*, *sand*, and *aggregate*, may have a special meaning in soil science. These terms and other special terms used in this report are defined in the Glossary at the back of the report.

Engineering classification systems

Two engineering systems are in general use for classifying soils. Most engineers prefer the system approved by the American Association of State Highway Officials (AASHO) (*1*).[3] The other system, established by the Waterways Experiment Station, Corps of Engineers, is the Unified system (*19*).

AASHO system.—This system is based on the field performance of soil material as used in the construction of highways. It classifies soil material in seven principal groups. The groups range from A-1, which are gravelly soils of high bearing capacity, to A-7, which are clayey soils that have low strength and low bearing capacity when wet. Within each of the principal groups, the relative engineering value of the soil material is indicated by a group index number. These numbers range from 0 for the best material to 20 for the poorest. For the soils tested, the group index number is shown in parentheses, following the soil group symbol in the next to last column of table 3.

[3] Italic numbers in parentheses refer to Literature Cited, p. 116.

Unified system.—Some engineers prefer to use the Unified soil classification system (*19*). In this system the soils are identified according to their texture and plasticity and are grouped according to their performance as engineering construction material. This system establishes 15 soil groups, which are divided into coarse-grained soils (8 classes), fine-grained soils (6 classes), and highly organic soils. The coarse-grained soils, in which more than half of the material is larger than the No. 200 sieve size, are identified by the symbols GW, GP, GM, GC, SW, SP, SM, or SC. The fine-grained soils, in which more than half of the material is smaller than the No. 200 sieve size, are identified by the smybols ML, CL, OL, MH, CH, or OH. The classification of soils that were tested according to this system is given in table 3.

Test data and engineering interpretations of soils

Much of the information in this section is given in tables 3, 4, and 5. Table 3 contains engineering test data obtained from testing samples of representative soils in Stark County. Table 4 briefly describes the soils and gives estimates of their physical properties important to engineering. Table 5 indicates the suitability of the soils for various engineering uses. A fourth table, table 6, shows the location of the known larger deposits of sand and gravel of good quality in the county.

The data in table 3 were obtained by the North Dakota State University in cooperation with the North Dakota State Highway Department and the U. S. Department of Commerce, Bureau of Public Roads. The engineering soil classifications in table 3 are based on data obtained by mechanical analyses and by tests to determine moisture density, liquid limit, and plastic limit. Mechanical analysis and tests to determine moisture density, liquid limit, and plasticity index were performed according to AASHO procedures.

For engineering purposes, the relationship of moisture content and the density of the soil material are important in compaction. If a soil material is compacted at successively higher moisture content, assuming that the compactive effort remains constant, the density of the compacted material increases until the optimum moisture content is reached. After that, the density decreases with increase in content of moisture. The highest dry density obtained in the compaction test is the maximum dry density. Data that show moisture density are important in earthwork, for as a rule, stability is obtained if a soil is compacted to about maximum density when it is at approximately the optimum moisture content. Moisture density tests in table 3 were made in accordance with AASHO Designation T 99-57 (*1*).

Mechanical analyses were made by combined sieve and hydrometer methods. Percentages of clay, obtained by the hydrometer method, are not suitable for determining U. S. Department of Agriculture textural classes of soils. To agricultural scientists, the term "clay," refers to mineral grains less than 0.002 millimeter in diameter. To engineers, the term "clay" refers to mineral grains less than 0.005 millimeter in diameter.

The test for liquid limit and plastic limit measures the effect of water on the consistence of the soil material. As the moisture content of a soil is increased from a dry state, the material changes from a semisolid to a plastic state. As the moisture content is further increased, the

TABLE 3.—*Engineering*

[Tests performed by the North Dakota State University in cooperation with the North Dakota State Highway Department and U.S. Officials

Soil name and location	Parent material	North Dakota State University report number (SCS)	Horizon	Depth	Moisture-density data[1]	
					Maximum dry density	Optimum moisture
				Inches	*Lb. per cu. ft.*	*Percent*
Lefor fine sandy loam:						
310 feet N. and 0.35 mile W. of the SE. corner of sec. 16, T. 137 N., R. 95 W. (Modal profile)	Material weathered from sandstone of the Golden Valley formation.	62	Ap	0–4	118	12
		24	B21	4–18	116	12
		56	C1	31–60	119	12
30 feet S. and 10 feet W. of the N¼ corner of sec. 22, T. 137 N., R. 95 W.	Material weathered from sandstone of the Golden Valley formation.	38	A1	0–5	106	16
		61	B22	16–25	119	12
		44	C2	44–57	118	11
0.45 mile W. and 0.25 mile S. of the NE. corner of sec. 35, T. 140 N., R. 94 W. (Coarse-textured profile)	Material weathered from sandstone and shale of the Golden Valley formation.	7	Ap	0–5	114	13
		54	B21	5–15	117	13
		36	C	31–60	115	14
Manning loam:						
40 rods E. and 27 rods N. of the SW. corner of sec. 34, T. 137 N., R. 92 W. (Modal profile)	Old terrace alluvium.	8	Ap	0–5	110	16
		26	B2	5–14	114	15
		25	C1	26–50	125	12
40 rods N. and 30 feet W. of the E¼ corner of sec. 7, T. 138 N., R. 95 W.	Old terrace alluvium.	51	A1	0–5	105	16
		34	B21 and B22.	5–17	114	14
		42	C1	35–52	129	11
30 feet S. and 0.2 mile E. of the NW. corner of the SW. quarter of sec. 15, T. 138 N., R. 95 W. (Contains thin clay coatings)	Stream alluvium.	3	A1	0–5	110	15
		35	B21	5–18	115	14
		29	C1	31–51	124	11
Morton silt loam:						
16 rods W. and 86 rods S. of the E¼ corner of sec. 6, T. 139 N., R. 94 W. (Modal profile)	Material weathered from loamstone and siltstone.	19	Ap	0–7	103	19
		40	B2	11–23	109	17
		41	Cca	23–36	103	18
		45	C1	36–54	114	16
0.35 mile S. of the NE. corner of sec. 28, T. 139 N., R. 91 W. (Varied B22 horizon)	Material weathered from shale.	60	A1	0–6	105	19
		14	B21	6–24	105	20
		11	B22	24–34	113	18
		31	C2	41–58	112	15
Morton loam:						
550 feet E. and 700 feet N. of the SW. corner of the SW¼ of sec. 32, T. 140 N., R. 96 W. (Coarse-textured substratum)	Material weathered from loamstone and sandstone.	58	Ap	0–5	116	14
		9	B22	16–29	110	14
		9	Cca	35–44	111	16
		39	C1	44–60	108	16
Parshall fine sandy loam:						
39 rods W. and 100 feet S. of the NE. corner of sec. 1, T. 138 N., R. 94 W. (Modal profile)	Sandy terrace alluvium.	68	Ap	0–6	118	12
		67	B2	6–18	118	11
		30	C1	33–58	109	14
1,230 feet S. and 1,010 feet E. of the NW. corner of sec. 13, T. 139 N., R. 94 W. (Fine-textured profile)	Sandy terrace alluvium.	15	Ap	0–7	108	16
		2	B2	7–28	112	15
		32	C1	46–67	116	12
180 feet E. and 30 feet N. of the SW. corner of sec. 11, T. 137 N., R. 93 W. (Maximal profile)	Material weathered from sandstone of the Fort Union formation.	28	Ap	0–7	112	14
		21	B21	7–17	113	15
		12	C2	52–60	115	14
Parshall sandy loam:						
68 rods N. and 62 rods W. of the SE. corner of sec. 18, T. 139 N., R. 94 W. (Coarse-textured profile)	Terrace sand.	63	A1	0–9	120	11
		33	B22	16–31	124	11
		48	C1	31–60	122	11

See footnotes at end of table.

test data

Department of Commerce, Bureau of Public Roads, in accordance with standard procedures of the American Association of State Highway (AASHO) *(1)*]

Mechanical analysis [2]								Liquid limit	Plasticity index	Classification	
Percentage of fraction passing sieve—				Percentage smaller than—						AASHO	Unified [3]
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0. 05 mm.	0. 02 mm.	0.005 mm.	0.002 mm.				
100	99	87	42	37	27	15	10	[4] NP	NP	A-4(1)	SM.
100	97	83	41	39	34	23	17	24	7	A-4(1)	SM-SC.
----------	100	86	43	40	35	18	10	25	4	A-4(2)	SM-SC.
----------	100	95	37	33	23	12	7	NP	NP	A-4(0)	SM.
----------	100	94	42	40	34	22	16	22	6	A-4(1)	SM-SC.
----------	100	99	41	36	29	16	10	20	1	A-4(1)	SM.
----------	100	90	40	36	28	17	9	NP	NP	A-4(1)	SM.
----------	100	97	42	39	31	22	16	22	5	A-4(1)	SM-SC.
100	99	96	23	19	13	9	6	NP	NP	A-2-4(0)	SM.
100	98	90	51	42	28	18	12	25	4	A-4(3)	ML-CL.
96	91	80	40	34	27	18	14	27	2	A-4(1)	SM.
59	45	35	16	14	11	8	6	[4] NP	NP	A-1-b(0)	SM.
100	99	97	44	34	19	11	7	NP	NP	A-4(2)	SM.
88	86	80	31	26	19	15	11	22	2	A-2-4(0)	SM.
65	39	22	7	5	3	1	0	NP	NP	A-1-a(0)	SW-SM.
98	96	90	41	35	25	16	12	25	4	A-4(1)	SM-SC.
99	98	93	43	36	26	16	12	22	5	A-4(2)	SM-SC.
79	64	56	17	12	9	6	4	NP	NP	A-2-4(0)	SM.
----------	100	98	76	69	50	31	23	30	9	A-4(8)	ML-CL.
----------	100	97	65	58	42	28	21	32	6	A-4(6)	ML.
----------	--------	100	82	73	48	17	11	31	2	A-4(8)	ML.
----------	--------	100	67	56	34	15	11	27	3	A-4(6)	ML.
99	94	91	70	61	42	24	15	32	6	A-4(7)	ML.
99	96	94	73	66	52	35	26	33	10	A-4(8)	ML-CL.
----------	100	98	94	88	66	39	29	40	19	A-6(12)	CL.
----------	--------	----------	99	90	66	37	27	34	14	A-6(10)	CL.
100	99	99	41	34	26	15	11	NP	NP	A-4(1)	SM.
100	99	99	54	47	36	26	20	26	7	A-4(4)	ML-CL.
----------	100	99	29	22	18	9	6	NP	NP	A-2-4(0)	SM.
----------	--------	100	27	22	14	8	5	NP	NP	A-2-4(0)	SM.
100	99	93	34	27	19	11	8	NP	NP	A-2-4(0)	SM.
----------	100	91	25	21	16	10	8	NP	NP	A-2-4(0)	SM.
----------	100	94	13	8	8	5	4	NP	NP	A-2-4(0)	SM.
----------	100	99	44	32	21	15	11	NP	NP	A-4(2)	SM.
----------	100	98	52	31	22	14	11	NP	NP	A-4(3)	ML.
100	99	97	37	25	16	12	12	NP	NP	A-4(0)	SM.
----------	100	96	26	22	15	8	4	NP	NP	A-2-4(0)	SM.
----------	100	98	33	29	22	16	12	NP	NP	A-2-4(0)	SM.
----------	100	97	30	28	26	17	14	NP	NP	A-2-4(0)	SM.
----------	100	71	29	24	16	8	5	NP	NP	A-2-4(0)	SM.
100	99	71	24	19	13	9	7	NP	NP	A-2-4(0)	SM.
99	97	69	16	15	14	10	9	NP	NP	A-2-4(0)	SM.

TABLE 3.—*Engineering*

[Tests performed by the North Dakota State University in cooperation with the North Dakota State Highway Department and U.S. Officials (AASHO) *(1)*]—Continued

Soil name and location	Parent material	North Dakota State University report number (SCS)	Horizon	Depth	Moisture-density data[1] Maximum dry density	Moisture-density data[1] Optimum moisture
				Inches	*Lb. per cu. ft.*	*Percent*
Promise silty clay: 90 feet N. and 10 rods W. of the SE. corner of sec. 31, T. 137 N., R. 93 W. (Modal profile)	Material weathered from clayey shale of the Fort Union formation.	57	Ap	0–4	95	22
		59	B21	4–17	94	21
		18	C1	29–50	99	22
100 feet W. and 1,480 feet S. of the NE. corner of sec. 11, T. 137 N., R. 94 W.	Material weathered from shale of the Fort Union formation.	16	Ap	0–5	99	20
		53	B21	5–15	103	18
		1	Cca	24–37	104	21
		65	C	37–54	104	20
Promise clay: 0.15 mile S. of the NW. corner of sec. 23, T. 138 N., R. 97 W.	Material weathered from shale of the White River formation.	22	A1	0–6	98	22
		43	B22	12–25	95	22
		5	Cca	34–45	99	22
Rhoades silt loam: 0.15 mile S. and 25 feet W. of the NE. corner of sec. 27, T. 137 N., R. 99 W. (Modal profile)	Material weathered from shale of the Fort Union formation.	4	B21	6–11	100	20
		10	Ccs	16–24	104	20
		46	C1	24–44	106	20
30 feet S. and 115 feet W. of the N¼ corner of sec. 35, T. 137 N., R. 99 W. (Fine-textured shale underlying material)	Material weathered from shale of the Fort Union formation.	13	B2	6–13	102	18
		20	Ccs1	13–22	104	20
		50	C2	37–55	100	19
39 rods N. and 42 rods E. of the W¼ corner of sec. 18, T. 137 N., R. 99 W.	Saline colluvium derived from the Fort Union formation.	17	B21	4–9	108	16
		66	Ccs	16–25	104	19
		37	C	25–57	110	21
Vebar fine sandy loam: 34 rods S. and 8 rods E. of the N¼ corner of sec. 30, T. 139 N., R. 94 W. (Modal profile)	Material weathered from sandstone.	47	Ap	0–7	115	14
		27	B22	14–32	109	15
		55	C1	32–43	110	16
0.1 mile S. of the NW. corner of sec. 13, T. 138 N., R. 91 W.	Material weathered from sandstone.	52	A1	0–9	110	14
		49	B2	9–20	113	14
		6	C1	32–43	110	16

[1] Based on AASHO Designation: T 99–57, Methods A and C (*1*).

[2] Mechanical analyses according to the AASHO Designation: T 88–57 (*1*). Results by this procedure may differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 mm. in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 mm. in diameter is excluded from calculations of grain-size fractions. The mechanical analysis data used in this table are

TABLE 4.—*Brief description of the soils and their*

Symbol on map	Soil name	Description of soil and site	Depth from surface	Classification USDA texture	Classification Unified[1]	Classification AASHO
			Inches			
ArA ArB	Arnegard loam, level. Arnegard loam, gently sloping.	Deep, well-drained soils that developed in local alluvium washed from silty and moderately sandy soils of the adjacent uplands. These soils are in swales and drainageways. They have a loamy surface layer 0 to 18 inches thick and a loamy subsoil 18 to 42 inches thick. The substratum is loamy or moderately sandy.	0 to 30	Loam or silt loam.	ML	A-4
			30 to 50	Loam or fine sandy loam.	ML or SM	A-4 or A-2

See footnotes at end of table.

test data—Continued

Department of Commerce, Bureau of Public Roads, in accordance with standard procedures of the American Association of State Highway

Mechanical analysis [2]								Liquid limit	Plasticity index	Classification	
Percentage of fraction passing sieve—				Percentage smaller than—						AASHO	Unified [3]
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.				
100	98	97	90	87	81	66	50	48	21	A-7-6(14)	ML-CL.
100	78	77	72	71	67	58	47	51	23	A-7-6(15)	MH-CH.
100	99	98	86	82	77	67	55	49	26	A-7-6(16)	CL.
--------	--------	100	94	88	74	55	44	47	22	A-7-6(14)	CL.
--------	--------	--------	91	80	59	43	34	40	17	A-6(11)	CL.
--------	--------	--------	98	95	83	54	40	48	21	A-7-6(14)	ML-CL.
--------	--------	100	98	93	77	47	33	44	24	A-7-6(14)	CL.
100	99	92	68	63	52	38	32	39	14	A-6(8)	ML-CL.
100	99	95	85	77	61	46	39	52	27	A-7-6(17)	CH.
--------	--------	--------	99	96	78	48	32	57	26	A-7-5(18)	MH-CH.
--------	--------	--------	96	92	69	45	37	53	30	A-7-6(19)	CH.
--------	--------	--------	98	92	69	43	37	49	27	A-7-6(17)	CL.
--------	--------	100	82	66	41	30	26	39	20	A-6(12)	CL.
--------	--------	--------	89	73	50	35	30	54	28	A-7-6(18)	CH.
--------	--------	--------	98	92	74	49	41	49	29	A-7-6(17)	CL.
--------	--------	--------	99	83	49	34	28	61	40	A-7-6(20)	CH.
100	99	98	65	56	42	30	24	29	10	A-4(6)	CL.
--------	100	99	77	71	58	46	37	39	18	A-6(11)	CL.
--------	100	99	77	71	60	45	36	37	19	A-6(12)	CL.
96	95	93	28	27	23	16	12	NP	NP	A-2-4(0)	SM.
--------	100	99	28	22	15	9	6	NP	NP	A-2-4(0)	SM.
--------	--------	100	20	16	11	7	4	NP	NP	A-2-4(0)	SM.
--------	100	99	32	27	19	10	6	NP	NP	A-2-4(0)	SM.
100	99	98	19	19	17	13	10	NP	NP	A-2-4(0)	SM.
--------	100	99	44	26	14	10	9	NP	NP	A-4(2)	SM.

not suitable for use in naming textural classes for soils. These data are based on total material but have been corrected for the percentage discarded in field sampling.

[3] Based on the Unified soil classification system (*19*). SCS and BPR have agreed that all soils having plasticity indexes within two points from A-line are to be given a borderline classification. Examples of borderline classifications obtained by this use are SM-SC, ML-CL, and MH-CH.

[4] Nonplastic.

estimated physical and chemical properties

Percentage passing sieve—			Permeability	Available water capacity	Reaction	Salinity	Dispersion	Shrink-swell potential
No. 4	No. 10	No. 200						
			Inches per hour	*Inches per inch of soil*	*pH value* (1:10)			
100	100	45 to 75	0.8- 2.5	0.18	6.2 to 7.0	None	Low	Low.
100	95 to 100	35 to 70	2.5- 5.0	0.15	6.9 to 8.5	None	Low	Low.

TABLE 4.—*Brief description of the soils and their estimated*

Symbol on map	Soil name	Description of soil and site	Depth from surface	Classification		
				USDA texture	Unified [1]	AASHO
			Inches			
BaB BaD Bd Bf BeD	Bainville and Midway soils, undulating. Bainville and Midway soils, steep. Bainville and Midway stony soils. Bainville-Shale outcrop complex. Bainville-Rhoades complex, strongly sloping.	Bainville: Undulating to steep soils that are shallow over soft, limy shale and are on the uplands. The surface layer is loam or silt loam.	0 to 60	Loam or silt loam.	ML	A-4
		Midway: Soils that have a surface layer of clay loam 2 to 6 inches thick and that are shallow over stratified silty clay shale.	0 to 4	Clay loam	CL	A-7-6
			4 to 48	Silty clay	CL	A-7-6
		Rhoades: Dense, shallow panspot soils that have a surface layer of loam about 3 inches thick over a clayey subsoil 8 to 27 inches thick. The substratum, below a depth of 27 inches, consists of stratified sodic and saline clay loam to silty clay shale.	0 to 3	Loam	ML	A-4
			3 to 27	Silty clay	CL	A-7-6
			27 to 60	Clay loam to silty clay.	ML or CL	A-6 or A-7
Bg	Banks and Glendive soils.	Banks: Deep loamy sands that developed in recent alluvium. These soils are on gently undulating or channeled bottom lands adjacent to the Heart River. The water table is at a depth of 4 to 8 feet.	0 to 60	Loamy sand	SM	A-1-b or A-2.
		Glendive: Fine sandy loams that have a surface layer 0 to 10 inches thick over 10 to 60 inches of stratified sandy loam, loamy fine sand, and loam. They occur with the Banks soils.	0 to 10	Fine sandy loam.	SM	A-2 or A-4.
			10 to 60	Sandy loam and loamy fine sand.	SM	A-2 or A-4.
Bk	Beckton complex.	Soils of the uplands that have a surface layer of fine sandy loam, 6 to 14 inches thick, over a claypan subsoil, 8 to 20 inches thick. The substratum is dense and clayey and consists of alkali-saline material weathered from shale.	0 to 11	Fine sandy loam.	SM	A-2 or A-4.
			11 to 21	Sandy clay loam.	SC	A-6
			21 to 50	Sandy clay	CL	A-6
BoA BoB BrA BrB	Belfield-Rhoades loams, level. Belfield-Rhoades loams, gently sloping. Belfield-Rhoades silty clay loams, level. Belfield-Rhoades silty clay loams, gently sloping.	Belfield: Deep soils developed on loam and clay loam shale and in alluvium. The surface layer is loam or silty clay loam 6 to 9 inches thick. The subsoil is clay loam or silty clay about 30 inches thick.	0 to 7	Loam or clay loam.	ML	A-4 or A-6.
			7 to 37	Clay loam or silty clay.	CL	A-6 or A-7.
		Rhoades: Dense, shallow panspot soils that have a surface layer of loam, about 3 inches thick, and a clayey subsoil 8 to 27 inches thick. The substratum is below a depth of 27 inches and consists of stratified saline-alkali clay loam or silty clay shale.	0 to 3	Loam	ML	A-4
			3 to 27	Silty clay	CL or CH	A-7-6 or A-6.
			27 to 60	Clay loam	CL	A-6
CbC CoD	Chama-Bainville loams, sloping. Chama-Bainville loams, strongly sloping.	Chama: Calcareous soils that have a weakly developed profile over silty material weathered from shale. The surface layer is loam or silt loam 3 to 7 inches thick, and the subsoil is silt loam 3 to 12 inches thick. The substratum is friable silt loam shale that has platy structure.	0 to 50	Loam or silt loam.	ML	A-4
		Bainville: Soils that have a thin surface layer of loam or silt loam over loam or silt loam, friable bedded shale. All layers are calcareous.	0 to 50	Loam or silt loam.	ML	A-4
ChB ChC	Cherry silty clay loam, gently sloping. Cherry silty clay loam, sloping.	Deep soils developed in calcareous local alluvium washed from the adjacent steep Bainville and Midway soils. The texture throughout the profile is heavy silty clay loam to light silty clay.	0 to 60	Silty clay loam.	CL	A-6

See footnotes at end of table.

physical and chemical properties—Continued

Percentage passing sieve— No. 4	No. 10	No. 200	Permeability	Available water capacity	Reaction	Salinity	Dispersion	Shrink-swell potential
			Inches per hour	*Inches per inch of soil*	*pH value* (1:10)			
100	95 to 100	63 to 94	0. 8– 2. 5	0. 18	8. 4 to 10. 0	Moderate	Moderate	Low.
100	98 to 100	75 to 98	0. 8– 2. 5	0. 18	7. 5 to 8. 0	None	Moderate	Moderate.
100	99 to 100	85 to 98	0. 2– 0. 8	0. 20	8. 0 to 9. 5	Moderate	High	Moderate to high.
100	99	50 to 70	0. 8– 2. 5	0. 17	6. 6 to 7. 1	Slight	High	Low.
100	96 to 100	95 to 99	0. 05– 0. 2	0. 16	7. 0 to 7. 8	Severe	High	Moderate to high.
100	98 to 100	70 to 98	0. 05– 0. 2	0. 14	7. 5 to 9. 0	Severe	High	Moderate.
98 to 100	97 to 100	12 to 30	2. 5–10. 0	0. 08	6. 8 to 7. 8	None	Low	Low.
98 to 100	97 to 100	20 to 50	0. 8– 2. 5	0. 15	6. 9 to 7. 5	None	Low	Low.
98 to 100	97 to 100	15 to 45	2. 5– 5. 0	0. 12	7. 2 to 8. 0	None	Low	Low.
97 to 100	95 to 100	20 to 45	2. 5– 5. 0	0. 14	6. 5 to 7. 0	Slight	Moderate	Low.
100	97 to 100	37 to 45	0. 05– 0. 5	0. 15	6. 9 to 7. 6	Moderate	High	Moderate.
98 to 100	97 to 100	70 to 85	0. 2– 0. 8	0. 14	8. 1 to 9. 2	Severe	High	Moderate.
99 to 100	94 to 100	55 to 76	0. 8– 2. 5	0. 17	5. 6 to 6. 5	None	Moderate	Moderate.
99 to 100	96 to 100	70 to 94	0. 2– 0. 8	0. 18	8. 0 to 8. 8	Slight	High	Moderate.
99 to 100	97 to 100	45 to 75	0. 8– 2. 5	0. 18	6. 5 to 7. 3	Slight	High	Low.
100	100	77 to 99	0– 0. 2	0. 18	7. 3 to 8. 5	Severe	High	High.
100	100	77 to 95	0. 05– 0. 8	0. 14	8. 0 to 9. 3	Severe	High	Moderate.
100	100	65 to 82	0. 8– 2. 5	0. 18	8. 0 to 10. 0	None to slight	Moderate	Low.
100	100	65 to 82	0. 8– 2. 5	0. 18	8. 4 to 10. 0	Slight to moderate	Moderate	Low to moderate.
100	100	75 to 90	0.8– 2.5	0.19	7.5 to 9.4	Slight	Moderate	Moderate.

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TABLE 4.—*Brief description of the soils and their estimated*

Symbol on map	Soil name	Description of soil and site	Depth from surface	Classification		
				USDA texture	Unified [1]	AASHO
			Inches			
Co	Colvin silt loam.	Deep, nearly level, poorly drained soils that are limy. The surface layer is 8 to 18 inches thick and is underlain by a wet, variable substratum of limy sandy loam to silty clay loam. The water table is at a depth of 1 to 4 feet.	0 to 12 12 to 55	Silt loam Sandy loam to silty clay loam.	ML SM to CL	A-4 A-2 or A-6
Dk	Dimmick clay.	Poorly drained, clayey soils in clay-filled basins in the uplands. The surface layer is dark silty clay loam or clay that has granular structure and is 3 to 8 inches thick. The subsoil is clay that has blocky structure and is about 19 inches thick. Beneath the subsoil is massive clay or silty clay.	0 to 5 5 to 60	Silty clay loam or clay. Clay	CL CH	A-6 A-7
Es	Eroded sandy land.	Severely eroded, undulating, moderately sandy and sandy land type that was formerly Lihen, Vebar, and Parshall soils. The subsoil is fine sandy loam or loamy fine sand 10 to 20 inches thick. The substratum is loamy fine sand.	0 to 15 15 to 55	Fine sandy loam or loamy fine sand. Loamy fine sand.	SM SM	A-2-4 A-2 or A-4
FaB FaC FgA	Farland silt loam, gently sloping. Farland silt loam, sloping. Farland, Arnegard and Grail silt loams, level.	Farland: Deep, well-drained soils of stream terraces. The surface layer is silt loam about 5 inches thick, and the subsoil is silty clay loam 18 to 32 inches thick. The substratum consists of thin layers of loamy material that is 32 to 60 inches thick.	0 to 5 5 to 32 32 to 60	Silt loam Silty clay loam. Loam and clay loam.	ML CL ML or CL	A-4 A-6 A-4 or A-6
		Arnegard: Deep, well-drained soils that developed in local alluvium washed from silty and moderately sandy soils of the adjacent uplands. This soil is in swales and drainageways. It has a loamy surface layer 0 to 18 inches thick and a loamy subsoil 18 to 42 inches thick. The substratum is loamy or moderately sandy. For estimated physical and chemical properties, see the Arnegard soils.				
		Grail: Deep, dark-colored soils that have a surface layer of silt loam about 10 inches thick over about 24 inches of silty clay loam or silty clay. The underlying material, between a depth of 34 and 60 inches, consists of limy and moderately saline alluvium that has a texture of silty clay loam.	0 to 10 10 to 34 34 to 60	Silt loam Silty clay loam. Silty clay loam.	ML CL CL	A-4 A-6 A-6
FlC Fm Fr	Flasher sandy loam, sloping. Flasher complex. Flasher-Rock outcrop, complex.	Flasher: Thin, sandy soils developed on soft sandstone. The surface layer is fine sandy loam or loamy fine sand about 4 inches thick. It rests on weakly consolidated or slightly weathered sandstone that breaks easily when disturbed. Included with the Flasher soils in mapping are areas of deep, moderately sandy Vebar and Parshall soils.	0 to 4 4 to 50	Fine sandy loam. Loamy fine sand.	SM SM	A-2-4 A-2-4
		Rock outcrop: Ledges and nearly bare, steep, sloping areas of moderately hard sandstone.	0 to 50	Fine sandy loam and loamy fine sand.	SM	A-2 or A-4

See footnotes at end of table.

physical and chemical properties—Continued

Percentage passing sieve—			Permea-bility	Available water capacity	Reaction	Salinity	Dispersion	Shrink-swell potential
No. 4	No. 10	No. 200						
			Inches per hour	*Inches per inch of soil*	*pH value* (1:10)			
100	96 to 100	80 to 90	0.8– 2.5	0.18	8.5 to 9.0	Slight	Low	Low.
100	90 to 100	30 to 90	0.8– 5.0	0.15–0.18	8.7 to 10.0	Moderate	Moderate	Moderate.
100	100	90 to 100	0.8– 2.5	0.20	6.6 to 7.0	None	Low	Moderate.
100	100	98 to 100	0.05– 0.2	0.20	6.9 to 7.5	Slight	High	High.
100	99 to 100	25 to 35	2.5– 5.0	0.14	6.2 to 6.8	None	Low	Low.
98 to 100	95 to 100	15 to 45	2.5–10.0	0.08	6.5 to 7.4	None	Low	Low.
99 to 100	95 to 100	55 to 76	0.8– 2.5	0.19	6.4 to 7.0	None	Low	Low.
100	99 to 100	77 to 99	0.8– 2.5	0.20	6.6 to 8.0	None	Moderate	Moderate.
100	95 to 100	60 to 90	0.8– 2.5	0.18	8.4 to 9.6	Slight	Moderate	Moderate.
99 to 100	95 to 100	60 to 80	0.8– 2.5	0.19	6.1 to 6.7	None	Low	Low.
99 to 100	98 to 100	65 to 90	0.2– 0.8	0.20	6.1 to 7.2	Slight	Moderate	Moderate.
99 to 100	98 to 100	60 to 80	0.2– 0.8	0.20	7.1 to 8.4	Slight	Moderate	Moderate.
96 to 100	95 to 100	25 to 35	2. 5– 5. 0	0. 15	6. 5 to 7. 2	None	Low	Low.
99 to 100	95 to 100	17 to 35	0. 8– 2. 5	0. 08	6. 8 to 7. 8	None	Low	Low.
95 to 100	95 to 100	15 to 45	0. 8– 5. 0	0. 10	6. 5 to 7. 9	None	Low	Low.

TABLE 4.—*Brief description of the soils and their estimated*

Symbol on map	Soil name	Description of soil and site	Depth from surface	Classification		
				USDA texture	Unified [1]	AASHO
			Inches			
Ga	Gallatin clay loam.	Deep, somewhat poorly drained soil formed in alluvium. This soil is in depressions and in overflow channels on bottom lands along the major streams. The surface layer is black clay loam about 13 inches thick, and the subsoil is loam or clay loam about 20 inches thick. The water table is at a depth of 3 to 6 feet.	0 to 13 13 to 33 33 to 55	Clay loam Loam or clay loam. Silty clay loam.	CL ML or CL CL	A-6 A-4 or A-6 A-6
Gf	Glendive fine sandy loam.	Deep, moderately well drained soil developed in moderately sandy alluvium on bottom lands along streams. It consists of about 12 inches of fine sandy loam over 40 inches of stratified loamy fine sand and fine sandy loam.	0 to 12 12 to 52	Fine sandy loam. Loamy fine sand.	SM SM	A-2 or A-4 A-2 or A-4
GrA GrB GrC Gs GtA GtB	Grail silty clay loam, level. Grail silty clay loam, gently sloping. Grail silty clay loam, sloping. Grail soils, saline. Grail-Rhoades silty clay loams, level. Grail-Rhoades silty clay loams, gently sloping.	Grail: Deep, dark-colored soils that have a surface layer of silty clay loam, about 10 inches thick, over a subsoil of silty clay about 18 inches thick. The substratum consists of 28 to 60 inches of alluvium that has a texture of silty clay loam. Rhoades: Dense, shallow panspot soils that have a surface layer of loam, about 3 inches thick, and a dense claypan subsoil 8 to 27 inches thick. The substratum is below a depth of 27 inches and consists of stratified saline-alkali clay loam or silty clay shale. For estimated physical and chemical properties, see the Belfield-Rhoades complexes.	0 to 10 10 to 28 28 to 60	Silty clay loam. Silty clay Silty clay loam.	CL CL CL	A-6 A-7-6 A-6
Gv	Gravelly land.	This land type consists of gravel pits, spoil piles, and undisturbed gravelly soil material in which about 4 inches of sandy loam is underlain by 30 to 60 inches of loamy gravel or gravelly sand.	0 to 4 4 to 45	Sandy loam Gravelly sand	SM SW-SM or SM.	A-2 or A-4 A-2
Ha	Havre loam.	Deep, nearly level soil developed in loamy alluvial material on bottom lands. It consists of about 60 inches of alternating layers of slightly calcareous loam and silt loam. At times, a temporary water table is in the lower part of the profile.	0 to 60	Loam or silt loam.	ML	A-4
He	Havre silty clay loam	This soil has a profile similar to that of Havre loam, except that the surface layer and one or more of the lower horizons have a texture of silty clay loam.	0 to 9 9 to 55	Silty clay loam. Loam and silty clay loam.	CL ML or CL	A-6 A-4 or A-6
Ho	Hoven soils.	Moderately deep, somewhat poorly drained soils in basins. The surface layer is clay loam 1 to 3 inches thick. The subsoil and substratum are dense, saline-alkali clay. The combined thickness of the surface layer and subsoil ranges from 24 to 35 inches.	0 to 3 3 to 60	Clay loam Clay	CL CH	A-6 A-7
LeB LeB2 LeC	Lefor fine sandy loam, undulating. Lefor fine sandy loam, undulating, eroded. Lefor fine sandy loam, sloping.	Well-drained soils of the uplands. The surface layer is fine sandy loam about 5 inches thick. It is underlain by about 27 inches of sandy clay loam that grades to a substratum of fine sandy loam that is 25 to 40 inches thick.	0 to 5 5 to 32 32 to 60	Fine sandy loam. Sandy clay loam. Fine sandy loam.	SM SM or SC SM	A-4 A-4 A-2 or A-4

See footnotes at end of table.

physical and chemical properties—Continued

Percentage passing sieve— No. 4	No. 10	No. 200	Permeability	Available water capacity	Reaction	Salinity	Dispersion	Shrink-swell potential
			Inches per hour	*Inches per inch of soil*	*pH value* (1:10)			
98 to 100	95 to 100	70 to 91	0.8–2.5	0.20	6.4 to 7.1	None	Moderate	Moderate.
99 to 100	95 to 100	50 to 75	0.8–2.5	0.20	6.7 to 7.3	None	Moderate	Moderate.
97 to 100	95 to 100	70 to 85	0.2–2.5	0.20	7.0 to 8.1	Slight	Moderate	Moderate.
99 to 100	97 to 100	28 to 45	0.8–2.5	0.15	6.8 to 7.3	None	Low	Low.
94 to 100	90 to 100	13 to 40	2.5–5.0	0.12	8.0 to 9.2	None	Low	Low.
100	100	75 to 90	0.8–2.5	0.19	6.1 to 6.7	None	Moderate	Moderate.
100	100	86 to 95	0.2–0.8	0.20	6.1 to 7.2	Slight	High	High.
100	100	75 to 90	0.2–0.8	0.19	7.0 to 8.2	Slight, except moderate for Grail soils, saline.	High	Moderate.
95 to 100	90 to 96	25 to 40	2.5–5.0	0.15	6.7 to 7.2	None	Low	Low.
55 to 80	39 to 65	7 to 20	(2)	0.04	8.3 to 9.4	None	Low	Low.
100	99 to 100	50 to 67	0.8–2.5	0.18	7.2 to 9.0	None	Low	Low.
100	95 to 100	60 to 85	0.8–2.5	0.20	7.5 to 8.0	Slight	Moderate	Moderate.
100	95 to 100	50 to 80	0.2–2.5	0.18	8.2 to 9.5	Slight	Moderate	Moderate.
100	100	90 to 100	0.8–2.5	0.18	6.6 to 7.0	Slight	High	Moderate.
100	100	98 to 100	0.05–0.2	0.15	7.3 to 9.0	Severe	High	High.
100	99 to 100	35 to 45	2.5–5.0	0.15	6.1 to 6.5	None	Low	Low.
100	97 to 100	40 to 50	0.8–2.5	0.16	6.5 to 7.6	None	Moderate	Low.
100	99 to 100	23 to 45	0.8–2.5	0.14	8.0 to 9.1	Slight	Low	Low.

TABLE 4.—*Brief description of the soils and their estimated*

Symbol on map	Soil name	Description of soil and site	Depth from surface	Classification: USDA texture	Unified [1]	AASHO
			Inches			
LeC2	Lefor fine sandy loam, sloping, eroded.					
LfB LlC	Lihen loamy fine sand, undulating. Lihen-Flasher loamy fine sands, rolling.	Lihen: Deep, excessively drained, sandy soils of the uplands. The texture is loamy fine sand or loamy sand to a depth of 60 inches. In places thin layers of gravelly material are in the lower part of the profile.	0 to 60	Loamy fine sand.	SM	A-2
		Flasher: Thin, sandy soils that developed over soft sandstone. The surface layer is loamy fine sand about 4 inches thick. Beneath the surface layer is slightly weathered sandstone that breaks easily.	0 to 4 4 to 50	Loamy fine sand. Loamy fine sand.	SM SM	A-2-4 A-2-6
LnA LnB	Little Horn and Duncom soils, level. Little Horn and Duncom soils, gently sloping.	Little Horn: Moderately deep soils of high uplands. The surface layer consists of about 6 inches of silt loam that grades to 10 to 25 inches of silty clay loam in the subsoil. The boundary is abrupt between the silty clay loam and indurated limestone.	0 to 6 6 to 24 24 to 50	Silt loam Silty clay loam. Bedrock	ML ML or CL (3)	A-4 A-4 or A-6 (3)
		Duncom: Soils of high uplands that are shallow over indurated limestone. They consist of about 11 inches of silt loam that rests on a layer of indurated limestone, 2 to 5 feet thick.	0 to 11 11 to 40	Silt loam Bedrock	ML (3)	A-4 (3)
MaA McA McB McC	Manning loam, level. Manning fine sandy loam, level. Manning fine sandy loam, gently sloping. Manning fine sandy loam, sloping.	Well-drained soils of high terraces. These soils have developed in loam or fine sandy loam alluvium that overlies a gravelly substratum. They have a surface layer of fine sandy loam or loam 4 to 7 inches thick and a loam subsoil that is 12 to 30 inches thick. Below the subsoil is the substratum of gravelly material and coarse sand.	0 to 6 6 to 25 25 to 55	Loam or fine sandy loam. Loam Gravelly sand	ML or SM-SC. SM or SC SW-SM or SM.	A-4 A-2 or A-4 A-1 or A-2
Md	Mine dumps.	This land type consists of open pits, underground lignite mines, and associated waste piles of raw shale. All of the areas have steep, irregular slopes.	0 to 50	(4)	(4)	(4)
MeA MeB MeC Mf MgD	Moreau silty clay, level. Moreau silty clay, gently sloping. Moreau silty clay, sloping. Moreau stony soils. Moreau-Midway silty clays, strongly sloping.	Moreau: Moderately deep, well-drained soils of the uplands. The surface layer is silty clay or silty clay loam, and the subsoil is silty clay. Their combined thickness is about 20 inches. Beneath the subsoil is a layer of dense, salty clay shale about 40 inches thick.	0 to 20 20 to 60	Silty clay Clay	CL MH-CH	A-7-6 A-7-6
		Midway: A shallow soil of uplands that has a surface layer of silty clay about 4 inches thick. The surface layer is underlain by partly weathered, soft clay and silty clay shale.	0 to 4 4 to 50	Silty clay Silty clay	CL CH	A-7-6 A-7-6
Mh Mk	Moreau-Midway-Rock outcrop complex. Moreau-Rock outcrop complex.	The Midway soils of the Moreau-Midway-Rock outcrop complex consist of 4 to 17 inches of sandy clay loam or sandy clay that rests on hard siliceous bedrock. In places bedrock crops out at the surface.	0 to 12 12 to 48	Sandy clay loam. Bedrock	CL (3)	A-6 (3)
Mm MnD MoC	Morton stony loam. Morton-Bainville complex, strongly sloping. Morton-Chama clay loams, sloping.	Morton: Deep, well-drained upland soils that consist of about 6 inches of loam or silt loam over 18 to 24 inches of clay loam. Below the clay loam is 20 to 30 inches of friable silt loam shale.	0 to 6 6 to 28 28 to 55	Loam or silt loam. Clay loam Silt loam	ML ML-CL ML or CL	A-4 A-4 A-4 or A-6

See footnotes at end of table.

physical and chemical properties—Continued

Percentage passing sieve— No. 4	No. 10	No. 200	Permeability	Available water capacity	Reaction	Salinity	Dispersion	Shrink-swell potential
			Inches per hour	*Inches per inch of soil*	*pH value* (1:10)			
99 to 100	95 to 100	17 to 35	2.5–10.0	0.08	6.2 to 7.4	None	Low	Low.
98 to 100	98 to 100	17 to 30	2.5–5.0	0.10	6.5 to 7.2	None	Low	Low.
98 to 100	98 to 100	17 to 30	0.8–2.5	0.08	6.8 to 7.8	None	Low	Low.
99 to 100	95 to 100	60 to 75	0.8–2.5	0.18	6.7 to 7.0	None	Low	Low.
99 to 100	98 to 100	60 to 75	0.8–2.5	0.20	6.8 to 8.5	None	Low	Low.
(3)	(3)	(3)	0–0.05	(3)	8.0 to 9.0	None	Low	Low.
99 to 100	95 to 100	60 to 75	0.8–2.5	0.18	6.8 to 7.5	None	Low	Low.
(3)	(3)	(3)	0–0.05	(3)	8.0 to 9.0	None	Low	Low.
98 to 100	96 to 99	40 to 55	2.5–5.0	0.15	6.9 to 7.5	None	Low	Low.
88 to 99	85 to 98	30 to 45	0.8–2.5	0.16	7.2 to 7.6	None	Low	Low.
55 to 80	39 to 65	7 to 20	(2)	0.04	8.8 to 9.4	None	Low	Low.
(4)	(4)	(4)	0.05–0.2	0.18	7.2 to 9.4	Moderate	Moderate	(4).
100	80 to 100	75 to 95	0.2–0.8	0.20	7.2 to 9.4	Slight	High	Moderate to high.
100	95 to 100	85 to 98	0.05–0.2	0.18	8.1 to 9.0	Severe	High	High.
100	98 to 100	75 to 98	0.8–2.5	0.20	7.5 to 8.0	None	Moderate	Moderate to high.
100	99 to 100	85 to 98	0.2–0.8	0.20	8.0 to 9.5	Moderate	Moderate	Moderate to high.
100	99 to 100	68 to 99	0.8–2.5	0.16	6.6 to 6.9	None	Low	Moderate.
(3)	(3)	(3)	0.05–0.2	(3)	6.8 to 7.4	None	(3)	(3).
99 to 100	94 to 100	40 to 75	0.8–2.5	0.18	6.3 to 7.5	None	Low	Low.
99 to 100	96 to 100	53 to 70	0.8–2.5	0.18	6.9 to 8.4	None	Moderate	Moderate.
100	100	50 to 99	0.8–2.5	0.18	7.8 to 9.4	Slight to moderate	Moderate	Moderate.

TABLE 4.—*Brief description of the soils and their estimated*

Symbol on map	Soil name	Description of soil and site	Depth from surface	Classification		
				USDA texture	Unified [1]	AASHO
			Inches			
MpC MpC2	Morton-Chama silt loams, sloping. Morton-Chama silt loams, sloping, eroded.	Bainville: Undulating to steep soils that are shallow over soft, limy shale and are on the uplands. The surface layer is loam or silt loam.				
		Chama: Calcareous soils that have a weakly developed profile over silty material weathered from shale. The surface layer is silty loam or light clay loam 3 to 7 inches thick, and the subsoil is silt loam 3 to 12 inches thick. The substratum is friable silt loam shale.	0 to 60	Loam or silt loam.	ML	A-4
MrA MrB	Morton and Farland clay loams, level. Morton and Farland clay loams, gently sloping.	Both the Morton and Farland soils of these units have a surface layer and subsoil of clay loam and a combined thickness of 28 to 34 inches. The substratum consists of 30 inches of stratified silt loam or clay loam shale or of old alluvium. The substratum is limy and is friable.	0 to 30 30 to 60	Clay loam Silt loam and clay loam.	CL ML or CL	A-6 A-4 or A-6
MsA MsB	Morton and Farland silt loams, level. Morton and Farland silt loams, gently sloping.	Morton: A description of the Morton soils is given under Morton stony loam and the Morton-Bainville and Morton-Chama complexes.				
		Farland: Deep, well-drained terrace soils that have a surface layer of silt loam, about 5 inches thick, and a subsoil of silty clay loam, 18 to 32 inches thick. The substratum consists of thin, mixed horizons of sandy loam, loam, and clay loam and is 32 to 60 inches thick.	0 to 5 5 to 32 32 to 60	Silt loam Silty clay loam. Loam and clay loam.	ML CL ML or CL	A-4 A-6 A-4 or A-6
MtA MtB MtC MtC2	Morton-Rhoades loams, level. Morton-Rhoades loams, gently sloping. Morton-Rhoades loams, sloping. Morton-Rhoades loams, sloping, eroded.	Morton: A description of the Morton soils is given under Morton stony loam and the Morton-Bainville and Morton-Chama complexes.				
		Rhoades: Dense, shallow panspot soils that have a surface layer of loam, about 3 inches thick, and a subsoil of silty clay, 10 to 25 inches thick. The substratum, below a depth of 25 inches, is stratified saline-alkali clay loam shale.	0 to 3 3 to 25 25 to 55	Loam Silty clay Clay loam	ML CL ML or CL	A-4 A-7-6 A-4
PaA	Parshall fine sandy loam, level.	Deep, dark-colored, moderately sandy soils developed mainly in old alluvium. The surface layer and subsoil consist of 23 to 48 inches of fine sandy loam. Beneath the subsoil are mixed thin layers of fine sandy loam and loamy fine sand that combined are 20 to 30 inches thick.	0 to 30 30 to 55	Fine sandy loam. Fine sandy loam and loamy fine sand.	SM SM	A-2-4 A-2 or A-4
PrA PrB	Promise silty clay, level. Promise silty clay, gently sloping.	Deep, well-drained, clayey soils in swales and on broad valley terraces. The surface layer is silty clay about 4 inches thick, and the subsoil is clay 16 to 24 inches thick. The soil material in the subsoil grades to limy and slightly salty silty clay of the substratum, which is 25 to 35 inches thick.	0 to 4 4 to 22 22 to 50	Silty clay Clay Silty clay	CL MH-CH CL	A-7-6 A-7-6 A-7-6

See footnotes at end of table.

physical and chemical properties—Continued

Percentage passing sieve—			Permea-bility	Available water capacity	Reaction	Salinity	Dispersion	Shrink-swell potential
No. 4	No. 10	No. 200						
	Inches per hour	*Inches per inch of soil*	*pH value (1:10)*					
100	100	65 to 82	0. 8– 2. 5	0. 18	7. 5 to 9. 4	None to slight	Moderate	Low.
100	100	77 to 95	0. 8– 2. 5	0. 20	6. 4 to 8. 3	None	Low	Moderate.
100	100	60 to 95	0. 8– 2. 5	0. 18	7. 8 to 9. 5	Slight	Moderate	Moderate.
99 to 100	95 to 100	55 to 76	0. 8– 2. 5	0. 18	6. 4 to 6. 8	None	Low	Low.
100	99 to 100	77 to 99	0. 8– 2. 5	0. 20	6. 6 to 8. 0	None	Moderate	Moderate.
100	95 to 100	60 to 90	0. 8– 2. 5	0. 18	8. 4 to 9. 6	Slight	Moderate	Low.
100	99 to 100	50 to 70	0. 8– 2. 5	0. 17	6. 4 to 7. 0	Slight	High	Low.
100	96 to 100	95 to 99	0. 05–0. 2	0. 16	7. 3 to 8. 4	Severe	High	Moderate to high.
100	98 to 100	70 to 98	0. 05–0. 2	0. 14	8. 1 to 9. 3	Severe	High	Moderate.
99 to 100	98 to 100	28 to 35	2. 5–5. 0	0. 14	6. 8 to 7. 2	None	Low	Low.
99 to 100	97 to 100	16 to 37	2. 5–10. 0	0. 10	8. 5 to 9. 0	None	Low	Low.
100	98 to 100	90 to 95	0. 2–0. 8	0. 20	6. 6 to 8. 7	None to slight	Moderate	Moderate to high.
100	88 to 99	72 to 92	0. 2–0. 8	0. 20	7. 5 to 9. 4	None to slight	High	High.
100	86 to 98	80 to 95	0. 2–0. 8	0. 18	8. 5 to 9. 7	Slight to moderate	High	High.

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TABLE 4.—*Brief description of the soils and their estimated*

Symbol on map	Soil name	Description of soil and site	Depth from surface	Classification		
				USDA texture	Unified [1]	AASHO
			Inches			
ReA ReB RgA RgB RgC	Regent silty clay loam, level. Regent silty clay loam, gently sloping. Regent-Moreau silty clay loams, level. Regent-Moreau silty clay loams, gently sloping. Regent-Moreau silty clay loams, sloping.	Regent: Deep, well-drained, moderately fine textured soils of the uplands. The surface layer is silty clay loam 4 to 10 inches thick. The soil material in the surface layer grades to silty clay loam and light silty clay in the subsoil, which is 15 to 30 inches thick. The substratum is silty clay loam bedded shale that is soft when dry and firm when moist.	0 to 7 7 to 26 26 to 60	Silty clay loam. Silty clay Silty clay loam.	CL CL CL	A-6 A-6 A-6
		Moreau: Moderately deep, well-drained upland soils that have a surface layer and subsoil of silty clay. The combined surface layer and subsoil are about 20 inches thick. They are underlain by dense, salty clay shale about 40 inches thick. Some areas of Rhoades loam are included in the Regent-Moreau complexes.	0 to 20 20 to 60	Silty clay Clay	CL MH-CH	A-7-6 A-7-6
RsA RsB	Rhoades and Belfield soils, level. Rhoades and Belfield soils, gently sloping.	Rhoades: Dense, shallow panspot soils that have a surface layer of loam about 3 inches thick over a subsoil of silty clay loam 8 to 27 inches thick. The substratum, below a depth of 27 inches, consists of stratified saline-alkali clay loam or silty clay shale and alluvium.	0 to 3 3 to 21 27 to 55	Loam Silty clay loam Clay loam or silty clay.	ML CL ML or CL	A-4 A-6 A-6 or A-7
		Belfield: Deep soils developed on loam and clay loam shale and in alluvium. The surface layer is loam or silty clay loam 6 to 9 inches thick. The subsoil is clay loam or silty clay about 30 inches thick.	0 to 7 7 to 37	Loam or silty clay loam. Clay loam or silty clay.	ML or CL CL	A-4 or A-6 A-6 or A-7
Sa	Saline alluvial land.	This land type consists of very salty loam, silty clay loam, and silty clay. A permanent water table is at or near the surface.	0 to 60	(4)	(4)	(4)
Sg ShA	Savage silty clay loam. Savage-Rhoades silty clay loams, level.	Savage: Deep, moderately well drained terrace soils. The surface layer is silty clay loam about 6 inches thick, and the subsoil is silty clay or silty clay loam 18 to 29 inches thick. The substratum is moderately saline and consists of stratified alluvium that has a texture of loam, silt loam, and silty clay loam.	0 to 6 6 to 26 26 to 55	Silty clay loam. Silty clay Silt loam or silty clay loam.	CL CL ML or CL	A-6 A-7-6 A-4 or A-6
		Rhoades: Dense, shallow panspot soils that have a surface layer of loam about 3 inches thick over a subsoil of silty clay loam 8 to 27 inches thick. The substratum, below a depth of 27 inches, consists of stratified saline-alkali clay loam or silty clay shale and alluvium. For estimated physical and chemical properties, see the Belfield-Rhoades complexes.				
Sm	Searing loam.	Moderately deep, well-drained soil that developed over hard, unconsolidated scoria. It consists of 15 to 30 inches of loam or silt loam over baked, reddish shale (scoria). The scoria breaks to small platelike pieces when the soil is disturbed.	0 to 22 22 to 40	Loam or silt loam. Bedrock	ML (3)	A-4 (3)

See footnotes at end of table.

physical and chemical properties—Continued

Percentage passing sieve— No. 4	No. 10	No. 200	Permeability	Available water capacity	Reaction	Salinity	Dispersion	Shrink-swell potential
			Inches per hour	*Inches per inch of soil*	*pH value* (1:10)			
98 to 100	80 to 95	75 to 95	0. 8–2. 5	0. 20	6. 8 to 7. 4	None	Moderate	Moderate.
100	95 to 100	85 to 98	0. 2–0. 8	0. 20	7. 2 to 8. 4	None to slight	High	High.
98 to 100	85 to 95	80 to 95	0. 2–0. 8	0. 18	8. 4 to 9. 5	Slight to moderate	High	Moderate.
100	80 to 100	75 to 95	0. 2–0. 8	0. 20	7. 2 to 9. 4	Slight	High	Moderate to high.
100	95 to 100	85 to 98	0. 05–0. 2	0. 18	8. 1 to 9. 0	Severe	High	High.
100	99	50 to 70	0. 8–2. 5	0. 18	6. 4 to 7. 0	Slight	High	Low.
100	96 to 100	95 to 99	0–0. 2	0. 18	7. 3 to 8. 4	Severe	High	Moderate.
100	98 to 100	70 to 98	0. 05–0. 8	0. 14	8. 1 to 9. 3	Severe	High	Moderate.
99 to 100	94 to 100	55 to 76	0. 8–2. 5	0. 17	5. 6 to 6. 5	None	Moderate	Moderate.
99 to 100	96 to 100	70 to 94	0. 2–0. 8	0. 18	8. 0 to 8. 8	Slight	High	Moderate.
[4]	[4]	[4]	[4]	[4]	7. 5 to 9. 3	Severe	High	Moderate.
100	100	75 to 90	0. 8–2. 5	0. 20	6. 8 to 7. 2	Slight	Moderate	Moderate.
100	100	86 to 95	0. 8–2. 5	0. 20	7. 0 to 8. 2	Moderate	High	Moderate to high.
100	80 to 95	60 to 85	0. 2–0. 8	0. 18	8. 4 to 9. 6	Moderate	High	Low to moderate.
100	100	65 to 82	0. 8–2. 5	0. 18	6. 6 to 7. 4	None	Low	Low.
[3]	[3]	[3]	2. 5–10. 0	0. 01	7. 0 to 8. 5	None	[3]	[3].

TABLE 4.—*Brief description of the soils and their estimated*

Symbol on map	Soil name	Description of soil and site	Depth from surface	Classification		
				USDA texture	Unified [1]	AASHO
			Inches			
So	Shale outcrop-Bainville complex.	Bainville: Shallow soils that have a texture of sandy loam to clay loam and that are underlain by soft, limy shale. Shale outcrop is a land type on steep valley slopes. It consists of outcrops of bare shale and sandstone mixed with areas of Bainville and Flasher soils.	0 to 40	Sandy loam to clay loam.	SM to CL	A-2 or A-6
Sp	Shale outcrop.	A steep land type consisting of outcrops of nearly bare shale and sandstone. Locally called badlands.	0 to 40	Sandy loam to silty clay.	SM to CL	A-2 or A-6
StA Sv	Straw loam, level Straw and Havre soils, channeled.	Straw: Deep, well-drained, dark-colored soils that developed in loamy alluvium on low terraces and bottom lands. They consist of 21 to 40 inches of loam or silt loam that rests on several thin layers of calcareous fine sandy loam, loam, and silt loam. Havre: This soil has a profile similar to that of Havre loam, except that the surface layer and one or more of the lower horizons have a texture of silty clay loam. For estimated physical and chemical properties, see Havre loam.	0 to 30 30 to 60	Loam or silt loam. Fine sandy loam and loam.	ML SM or ML	A-4 A-2 or A-4
VaE	Valentine fine sand, hilly	A very sandy, excessively drained soil of the uplands. It has a texture of loamy fine sand and sand to a depth of about 60 inches.	0 to 60	Loamy sand and sand.	SM or SP	A-2
VfD VmC VpB VpC	Vebar-Flasher fine sandy loams, strongly sloping. Vebar-Manning fine sandy loams, sloping. Vebar-Parshall fine sandy loams, undulating. Vebar-Parshall fine sandy loams, sloping.	Vebar: Deep, well-drained, moderately sandy soils of the uplands. The surface layer and subsoil combined are 25 to 45 inches thick and have a texture of fine sandy loam. The substratum is 15 to 30 inches thick and has a texture of loamy fine sand. Flasher: Thin, sandy soils developed on soft sandstone. The surface layer is fine sandy loam or loamy fine sand about 4 inches thick. It rests on weakly consolidated or slightly weathered sandstone that breaks easily when disturbed. For estimated physical and chemical properties, see the Flasher soils. Manning: Well-drained soils of high terraces. These soils have developed in moderately sandy and gravelly alluvium. They have a surface layer of fine sandy loam or loam 4 to 7 inches thick and a loam subsoil that is 12 to 30 inches thick. Below the subsoil is the substratum of gravelly material and coarse sand. For estimated physical and chemical properties, see the Manning soils. Parshall: Deep, dark-colored, moderately sandy soils developed mainly in old alluvium. The surface layer and subsoil consist of 23 to 48 inches of fine sandy loam. Beneath the subsoil are mixed thin layers of fine sandy loam and loamy fine sand that combined are 20 to 30 inches thick. For estimated physical and chemical properties, see the Parshall soil.	0 to 35 35 to 55	Fine sandy loam. Loamy fine sand.	SM SM	A-2-4 A-2 or A-4

See footnotes at end of table.

physical and chemical properties—Continued

Percentage passing sieve—			Permea-bility	Available water capacity	Reaction	Salinity	Dispersion	Shrink-swell potential
No. 4	No. 10	No. 200						
			Inches per hour	*Inches per inch of soil*	*pH value* (1:10)			
96 to 100	95 to 100	25 to 85	0. 05–2. 5	0. 14–0. 18	8. 2 to 10. 0	None to slight	High	Low to moderate.
96 to 100	95 to 100	25 to 98	0. 05–2. 5	0. 14–0. 18	8. 2 to 10. 0	Slight to moderate.	High	Low to moderate.
100	99 to 100	50 to 67	0. 8–2. 5	0. 18	6. 6 to 8. 9	None	Low	Low.
94 to 100	90 to 100	13 to 65	2. 5–5. 0	0. 15	9. 0 to 9. 2	None	Moderate	Low.
100	98 to 100	3 to 25	2. 5–10. 0	0. 03	6. 1 to 7. 0	None	Low	Low.
96 to 100	95 to 100	25 to 35	2. 5–5. 0	0. 15	6. 2 to 7. 4	None	Low	Low.
100	100	20 to 45	5. 0–10. 0	0. 08	6. 2 to 7. 8	None	Low	Low.

TABLE 4.—*Brief description of the soils and their estimated*

Symbol on map	Soil name	Description of soil and site	Depth from surface	Classification		
				USDA texture	Unified [1]	AASHO
			Inches			
Wa	Wet alluvial land	This land type consists of very poorly drained soil material in depressions and in overflow channels of the bottom lands. Included in mapping are areas of soils that have a surface layer of sandy loam to silty clay. The areas are flooded during parts of each year.	0 to 50	(4)	SM to CL	A–2 or A–6
Wb	Wibaux soils	Steep, shallow soils of the uplands. They developed over hard, baked shale (scoria). The surface layer is loam 2 to 14 inches thick. It is underlain by hard, reddish shale. The shale breaks into platelike pieces when it is disturbed.	0 to 7 7 to 40	Loam Bedrock	ML (3)	A–4 (3)

[1] The Soil Conservation Service and Bureau of Public Roads have agreed to consider that all soils having plasticity indexes within two points from A-line are to be given a borderline classification. Examples of borderline classifications obtained by this use are SM–SC SW–SM, MH–CL, and ML–CL.

TABLE 5.—*Engineering*

Soil series and map symbols	Suitability as a source of—				Highway location
	Topsoil	Sand	Gravel	Road fill	
Arnegard (ArA, ArB, FgA)	Excellent	Not suitable	Not suitable	Poor to not suitable for a base; generally fair to good for subgrade and subbase; fair to good compaction.	Slightly to highly susceptible to frost action; generally slightly plastic to nonplastic.
Bainville (BaB, BaD, Bd, BeD, Bf, CbC, CbD, MnD, So).	Poor	Not suitable	Not suitable	Poor to fair for subgrade, but not suitable for other uses; poor to good compaction with control or if roller is used.	Moderately to very highly susceptible to frost action.
Banks (Bg)	Poor	Fine and medium sands; fair if washed and used for concrete.	Not suitable	Fair to good for subgrade and subbase; not suitable for base; good compaction with close control.	Slightly susceptible to frost action; nonplastic; subject to streambank cutting and overflow.
Beckton (Bk)	Fair	Not suitable	Not suitable	Surface layer and subsoil are a good source; the substratum is poor.	Slightly susceptible to frost action; nonplastic to a depth of 25 feet; substratum is plastic.
Belfield (BoA, BoB, BrA, BrB, RsA, RsB).[2]	Good	Not suitable	Not suitable	Poor to fair	Moderately to highly susceptible to frost action.
Chama (CbC, CbD, MoC, MpC, MpC2).	Fair	Not suitable	Not suitable	Poor	Moderately susceptible to frost action.

See footnotes at end of table

physical and chemical properties—Continued

Percentage passing sieve— No. 4	No. 10	No. 200	Permeability	Available water capacity	Reaction	Salinity	Dispersion	Shrink-swell potential
			Inches per hour	*Inches per inch of soil*	*pH value* (1:10)			
98 to 100	95 to 100	25 to 80	0.8–2.5	0.18	6.8 to 7.5	None to slight	Low	Low to moderate.
100	100	65 to 82	0.8–2.5	0.18	6.5 to 7.5	None	Low	Low.
(3)	(3)	(3)	2.5–1.0	0.01	(3)	(3)	(3)	(3).

[2] More than 10.
[3] Bedrock.
[4] Variable.

interpretations of soils [1]

Dikes or levees	Low dams: Reservoir area	Low dams: Embankment	Irrigation, including water spreading	Field terraces and diversion terraces	Waterways
Good permeability; fair stability.	Fair	Fair stability; fair for impervious cores.	Good to excellent; moderate water-holding capacity; moderate intake rate.	Not needed	High fertility; moderate water-holding capacity.
Nearly impermeable; fair stability, but lime and gypsum may influence stability.	Good	Fair stability with control, but lime and gypsum may influence stability; suitable for impervious cores with control.	Not suitable	Not suitable	Low fertility; highly erodible.
Fair stability	Poor	Fair stability	Suitable; low water-holding capacity; highly erodible.	Suitable for diversion terraces.	Low fertility; highly erodible.
Fair stability	Fair	Fair stability; impervious substratum.	Not suitable	Suitable	Suitable.
Impermeable; fair to good stability.	Good	Fair to good stability; suitable for impervious cores.	Fair for sprinkler irrigation; good for water spreading.	Suitable	Suitable.
Suitable; highly erodible.	Poor	Poor stability, except with proper control of compaction.	Not suitable	Suitable	Suitable.

TABLE 5.—*Engineering*

Soil series and map symbols	Suitability as a source of—				Highway location
	Topsoil	Sand	Gravel	Road fill	
Cherry (ChB, ChC)	Fair	Not suitable	Not suitable	Poor to fair for subgrade; not suitable for base or subbase.	Moderately to highly susceptible to frost action.
Colvin (Co)[3]	Good	Not suitable	Not suitable	Poor	Moderately to highly susceptible to frost action; the water table is 1 to 3 feet below the surface.
Dimmick (Dk)[3]	Fair	Not suitable	Not suitable	Poor	Highly susceptible to frost action; susceptible to ponding; highly plastic.
Duncom (LnA, LnB)	Poor	Not suitable	Not suitable	Not suitable	Shallow over limestone.
Farland (FaB, FaC, FgA, MrA, MrB, MsA, MsB).	Good	Not suitable	Not suitable	Poor	Moderately susceptible to frost action.
Flasher (FlC, Fm, Fr, L1C, VfD).	Fair	Not suitable	Not suitable	Fair to good for subgrade and subbase; poor for base.	Slightly susceptible to frost action.
Gallatin (Ga)	Good	Not suitable	Not suitable	Poor to fair for subgrade, subbase, and base.	Poor; high water table; moderately susceptible to frost action.
Glendive (Bg, Gf)	Good	Not suitable	Not suitable	Fair to good for subgrade and subbase; poor for base.	Slightly to moderately susceptible to frost action.
Grail (FgA, GrA, GrB, GrC, Gs, GtA, GtB).[3]	Excellent	Not suitable	Not suitable	Poor for subgrade; not suitable for base or subbase.	Moderately susceptible to frost action.
Gravelly land (Gv)	Good	Good source of material for a road base; wash if used for concrete.	Mixed strata of good road base material; wash if used for concrete.	Fair to good; good compaction.	Not susceptible or only slightly susceptible to frost action.
Havre (Ha, He, Sv)	Fair	Not suitable	Not suitable	Fair for subgrade, subbase, and base.	Moderately susceptible to frost action.
Hoven (Ho)	Poor	Not suitable	Not suitable	Poor to fair for subgrade; not suitable for subbase or base.	Moderately to highly susceptible to frost action.
Lefor (LeB, LeB2, LeC, LeC2).	Fair	Not suitable	Not suitable	Poor to fair	Moderately susceptible to frost action.
Lihen (LfB, LlC)	Good	Fine and medium sands; fair (if washed).	Not suitable	Fair to good for subgrade and subbase; poor for base.	Slightly susceptible to frost action.

See footnotes at end of table.

interpretations of soils [1]—Continued

Dikes or levees	Low dams		Irrigation, including water spreading	Field terraces and diversion terraces	Waterways
	Reservoir area	Embankment			
Impermeable; fair stability.	Good	Fair to good stability; suitable for impervious cores and blankets. No seepage control needed.	Not suitable	Suitable	Suitable.
Poor to fair stability	Good	Poor stability; control of compaction necessary.	Not suitable	Not suitable	Suitable.
Fair stability; suitable for impervious cores and blankets.	Good	Fair stability with flat slopes; suitable for thin cores and blankets.	Not suitable	Not needed	Not needed.
Poor; shallow over limestone.	Poor	Poor; shallow over limestone.	Not suitable	Not suitable	Not suitable.
Fair stability	Good	Fair stability with flat slopes; suitable for thin cores and blankets.	Suitable	Suitable	Suitable.
Fair stability	Poor	Fair stability	Not suitable	Not suitable for field terraces; suitable for diversion terraces.	Not suitable.
Fair stability	Good	Fair stability; impervious.	Not feasible, because of drainage problems.	Not applicable	Not applicable.
Fair to good stability	Fair to good	Fair to good stability with control.	Suitable	Suitable	Suitable.
Stable	Good	Stable; suitable for impervious cores and blankets.	Suitable	Suitable	Suitable.
Fair stability	Poor	Fairly stable with good compaction.	Not suitable	Not needed	Not suitable.
Fair stability	Good	Fair stability	Suitable	Suitable for diversion terraces.	Suitable.
Fair to good stability	Good	Fair to good stability; suitable for blanket and dike sections.	Not suitable	Suitable for diversion terraces.	Not needed.
Fair stability	Fair to good	Fair to good stability; suitable for impervious cores.	Not suitable	Suitable	Suitable.
Fair stability; erodible by wind.	Poor	Fair stability	Suitable	Suitable for diversion terraces.	Suitable.

TABLE 5.—*Engineering*

Soil series and map symbols	Suitability as a source of—				Highway location
	Topsoil	Sand	Gravel	Road fill	
Little Horn (LnA, LnB)	Fair	Not suitable	Not suitable	Fair for subgrade and subbase.	Moderate depth over limestone.
Manning (MaA, McA, McB, McC, VmC).	Good	Fair to good for road base material below a depth of 2 feet; wash if used for concrete.	Fair to good for road base material below a depth of 2 feet; wash for concrete.	Fair to good; good compaction.	Slightly susceptible to frost action; nonplastic.
Midway (BaB, BaD, Bd, MgD, Mn).[4]	Poor	Not suitable	Not suitable	Poor to fair for subgrade; not suitable for subbase and base.	Moderately to very highly susceptible to frost action.
Moreau (MeA, MeB, MeC, Mf, MgD, Mh, Mk, RgA, RgB, RgC).	Fair	Not suitable	Not suitable	Poor to fair for subgrade; not suitable for subbase and base.	Moderately to very highly susceptible to frost action.
Morton (Mm, MnD MoC, MpC, MpC2, MrA, MrB, MsA, MsB, MtA, MtB, MtC, MtC2).	Good	Not suitable	Not suitable	Poor to fair for subgrade; not suitable for subbase and base.	Moderately susceptible to frost action.
Parshall (PaA, VpB, VpC)	Good	Fair to good strata for road base; fair if washed and used for concrete.	Not suitable	Fair to good for subgrade and subbase; poor for base.	Slightly susceptible to frost action.
Promise (PrA, PrB)	Good	Not suitable	Not suitable	Poor to fair for subgrade; not suitable for base and subbase.	Moderately to very highly susceptible to frost action.
Regent (ReA, ReB, RgA, RgB, RgC).	Good	Not suitable	Not suitable	Poor to fair for subgrade; not suitable for base and subbase.	Moderately to very highly susceptible to frost action.
Rhoades (BeD, BoA, BoB, BrA, BrB, GtA, GtB, MtA, MtB, MtC, MtC2, RsA, RsB, ShA).	Fair	Not suitable	Not suitable	Poor to fair for subgrade; not suitable for base and subbase; fair to poor compaction.	Moderately to highly susceptible to frost action; highly plastic material.
Saline alluvial land (Sa)[3]	Not suitable.	Not suitable	Not suitable	Poor	Moderately to highly susceptible to frost action; highly corrosive to pipelines.
Savage (Sg, ShA)	Good	Not suitable	Not suitable	Poor to fair for subgrade; not suitable for base or subbase.	Moderately to highly susceptible to frost action.
Searing (Sm)	Good	Not suitable	Not suitable	Poor to fair for subgrade; not suitable for base or subbase.	Moderately to very highly susceptible to frost action.
Straw (StA, Sv)	Good	Not suitable	Not suitable	Surface layer poor; subsoil good.	Moderately susceptible to frost action.

See footnotes at end of table.

interpretations of soils [1]—Continued

Dikes or levees	Low Dams		Irrigation, including water spreading	Field terraces and diversion terraces	Waterways
	Reservoir Area	Embankment			
Poor; moderate depth over limestone.	Poor	Poor; moderate depth over limestone.	Not suitable	Not suitable	Not suitable.
Fair stability	Poor	Fair stability; uppermost 2 feet can be used for impervious cores and blankets.	Suitable	Suitable	Suitable.
Impermeable; fair stability.	Good	Fair stability; suitable for thin cores and and blankets.	Not suitable	Field terraces not needed; suitable for diversion terraces.	Not suitable.
Impermeable; fair stability.	Good	Fair stability; suitable for cores and blankets.	Not suitable	Field terraces may be needed; suitable for diversion terraces.	May be needed; undercut and backfill surface material.
Fair stability	Good	Fair stability with flat slopes.	Suitable	Suitable	Suitable.
Fair stability; erodible by wind.	Poor	Fair stability	Suitable	Suitable	Suitable.
Impermeable; fair stability.	Good	Fair stability; suitable for thin cores and blankets.	Not suitable	Field terraces may be needed; suitable for diversion terraces.	May be needed; undercut and backfill surface material.
Impermeable; fair stability.	Good	Fair stability; suitable for thin cores and blankets.	Not suitable	Field terraces may be needed; suitable for diversion terraces.	May be needed; undercut and backfill surface material.
Impermeable; fair to good stability.	Good	Fair to good stability; suitable for impervious cores and blankets.	Not suitable	Not suitable for field terraces; diversion terraces may be needed.	Poor.
Poor stability	Fair	Poor stability	Not suitable	Not suitable	Not suitable.
Impermeable; stable	Good	Stable; suitable for impervious cores and blankets.	Fair to good	Not needed in most places.	Suitable.
Poor stability	Good	Poor stability, but may be used with proper control.	Poor to fair	Suitable	Suitable.
Fair stability	Fair to good	Fair stability; suitable for impervious cores and blankets.	Suitable	Suitable for diversion terraces.	Suitable.

TABLE 5.—*Engineering*

Soil series and map symbols	Suitability as a source of—				Highway location
	Topsoil	Sand	Gravel	Road fill	
Valentine (VaE)	Poor	Fine and medium sands; fair if washed and used for concrete.	Not suitable	Fair to good for subgrade and subbase; not suitable for base; good compaction with close control.	Slightly susceptible to frost action; nonplastic.
Vebar (VfD, VmC, VpB, VpC).	Good	Fair	Not suitable	Fair to good for subgrade and subbase; poor for base.	Slightly susceptible to frost action.
Wet alluvial land (Wa)	Poor	Poor	Poor	Poor	Moderately susceptible to frost action.
Wibaux (Wb)[5]	Poor	Not suitable	Not suitable	All parts fair to good.	Slightly susceptible to frost action.

[1] Does not include interpretations for Eroded sandy land (Es), Mine dumps (Md), and Shale outcrop (Sp).
[2] Below a depth of 25 inches, salts will affect properties of these soils.
[3] These soils are corrosive to pipelines. The Dimmick and Grail soils and Saline alluvial land are highly corrosive, and Wet alluvial land is highly corrosive where salts are present.

material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material passes from a semisolid to a plastic state. The liquid limit is the moisture content at which the soil material passes from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is in a plastic condition. Nonplastic, indicated by the symbol NP, applies to soils that have granular structure or that are without cohesion. For these soils, the liquid or plastic limit cannot be determined.

Table 4 describes the soils briefly and shows the depth of each major horizon from the surface. It also gives the USDA texture and the estimated Unified and AASHO classifications.

The column that shows permeability gives the estimated rate, expressed in inches per hour, at which water moves through a soil in place. The estimates are based on the structure and texture of the soils and on cylindric infiltrometer tests that were run to determine the infiltration rates for irrigation purposes.

The estimates for available water capacity show the approximate amount of capillary water in the soil that is available to plants after the free water has drained out. This is measured in inches per inch of soil material.

The column titled "Reaction" indicates the salinity or alkalinity of the soils. A pH value of 7.0 is neutral, a pH value of less than 7.0 is acid, and a pH value of more than 7.0 is alkaline.

In table 4 estimates of the salinity of the soils are given. These are based on the electrical conductivity of saturated soil extract as expressed in millimhos per centimeter at 25° C. A rating of *none* is given for electrical conductivity of saturated soil extract of less than 2 millimhos per centimeter; of *slight*, for 2 to 4 millimhos per centimeter; of *moderate*, for 4 to 8 millimhos per centimeter; and of *severe*, for 8 to 16 millimhos per centimeter.

Dispersion, in table 4, is rated as *high*, *moderate*, and *low*, depending on how readily the soil structure breaks down or slakes because of excess moisture. A rating of *high* indicates that the soil aggregates slake readily. The soils that have a *low* rating are resistant to dispersion.

The ratings for shrink-swell potential are also expressed as *high*, *moderate*, and *low*. Generally, coarse sands and gravel have a low shrink-swell potential. Montmorillonite clays, on the other hand, have a high shrink-swell potential, as evidenced by extensive shrinkage cracks that form as the soils dry.

The engineering interpretations in table 5 are based on the test data in table 4, on information in the rest of the report, and on experience with the same soils in other counties. They should be used only as a guide, and ought to be supplemented with information obtained in field investigations to provide more complete data for planning construction work, because major variations in the soils may occur within the depth of the proposed excavation.

Using the information in the soil survey report enables the soils engineer to keep to a minimum the number of samples for laboratory testing. The ratings given for such structures as embankments, dikes, and levees are based on the material below the topsoil so that the part of the soil profile that is high in content of organic matter will be excluded. Material high in content of organic matter is not considered stable enough for many types of structures.

In table 5 the soils are rated according to their suitability as a source of topsoil. The ratings range from *unsuitable* for Saline alluvial land to *excellent* for some

interpretations of soils [1]—Continued

Dikes or levees	Low dams		Irrigation, including water spreading	Field terraces and diversion terraces	Waterways
	Reservoir area	Embankment			
Fair stability	Poor	Fair stability	Suitable; low water-holding capacity.	Not suitable	Not needed.
Fair stability; erodible by wind.	Poor	Fair stability	Suitable	Suitable for diversion terraces.	Suitable.
Fair stability, except in upper layers where there is a large amount of organic matter.	Good	Suitable for impervious cores.	Not suitable	Not suitable	Not suitable.
Fair stability if clinker fragments have been removed.	Good	Fair stability if clinker fragments have been removed.	Not suitable	Not suitable	Not suitable.

[4] The Midway soils contain some salts.
[5] Contains clinker fragments.

of the loams and silty clay loams. The ratings given are based primarily on the fertility and depth of the soil material to be used for topsoil. A rating of *poor* or of *not suitable* is generally given, because the soil material is too sandy to be high in fertility or because it is saline or wet.

Few of the soils are suitable as a source of sand and gravel. Those that are suitable should be explored extensively to find material that meets gradation requirements. Table 6, prepared from data of the North Dakota State Highway Department, shows the approximate amount of sand and gravel in known deposits in the county and gives other facts about these deposits. Several other deposits are in the county, but their location was not shown in the table because the sand or gravel is of limited or of poor quality or the supply has been exhausted.

In the deposits mentioned in table 6, the sand and gravel are well sorted. The proportion of sand is high, but there is enough silt and clay to give the material a fairly high liquid limit and plasticity index. Also, some of the coarser aggregates consist of soft particles of shale, scoria, iron oxide, and coal, and as a result, the gravel is unsuitable for concrete. The bank-run aggregates have been successfully used for roads that have a gravel surface and as a base for asphalt and cement surfacing.

The ratings given for suitability as a source of road fill and the features that affect suitability for the location of highways refer to the subgrade for bituminous or paved surfacing. Sand is the best subgrade for roads of this type. Soils that have a high content of silt-size material or that have a high water table are moderately or highly susceptible to frost action. The Banks soils are poorly suited as a location for a highway, because they are subject to streambank cutting and overflow.

The ratings for stability in the columns titled "Dikes or Levees" and "Embankments," and also statements as to whether or not the soil is impervious, refer to the stability and permeability of these soils in low structures. This information can be used as preliminary data where large irrigation structures, grade stabilization structures, or flood control structures are planned. It is assumed, of course, that a more detailed geologic investigation will be made where a large structure is planned.

The relative ratings of *poor*, *fair*, and *good*, to show the suitability of the soils for reservoir areas for impounding water, are based on the ability of the soils to hold water and to prevent excessive seepage.

In the column that shows suitability for irrigation and water spreading, the ratings are based partly on the water-holding capacity of the soils and on the rate at which the soils take in water. For many of the soils, a rating of unsuitable for irrigation and water spreading is given, because of a relatively impermeable substratum, an excessive intake rate, or low water-holding capacity. More information about the suitability of the various soils and slopes for different kinds of irrigation are given in "Irrigation Guides for Western North Dakota and Eastern North Dakota."[4]

Ratings of the soils for field terraces, diversion terraces, and waterways are based on the need for these practices, as well as on the capabilities of the soils as structural material.

Other factors that affect use of the soils for engineering purposes.—Factors not indicated in table 5, but that affect the suitability of some of the soils for engineering purposes, are lime and gypsum, which are likely to influence the stability of the Bainville soils. The Banks soils

[4] Published by the Soil Conservation Service in 1956; available in local Soil Conservation Service offices.

TABLE 6.—*Deposits of sand and gravel in Stark County, N. Dak.*

[Data from surveys and analyses made by North Dakota State Highway Department]

Location	Quantity available	Content of shale and soft rock	Content of colloids [1]	Plasticity index	Liquid limit	Percentage retained on a ¼-inch sieve
	Tons	*Percent*	*Percent*			
NW¼ sec. 28, T. 138 N., R. 92 W	52, 500	0. 3	11. 4	0	0	26
NE¼ sec. 6, T. 138 N., R. 93 W	22, 500	. 7	9. 2	5. 6	22. 8	29
N½SE¼ sec. 14, T. 138 N., R. 93 W	54, 400	1. 1	5. 6	0	0	29
N½SW¼ sec. 14, T. 138 N., R. 93 W	45, 000	1. 6	5. 4	0	0	28
SW¼ sec. 22, T. 139 N., R. 94 W	37, 500	1. 5	9. 3	6. 8	22. 8	29
E½ sec. 28, T. 139 N., R. 94 W	135, 000	. 8	4. 4	0	0	14
E½ sec. 34, T. 139 N., R. 94 W	65, 173	1. 6	16. 4	6. 0	23. 9	40
NE¼ sec. 2, T. 139 N., R. 95 W	5, 000	6. 0	9. 2	1. 3	19. 1	37
N½ sec. 13, T. 139 N., R. 95 W	(2)	. 9	10. 8	3. 9	18. 2	41
SE¼ sec. 8, T. 140 N., R. 95 W	24, 000	2. 7	6. 8	0	0	33
NE¼ sec. 5, T. 140 N., R. 96 W	300, 000	. 2	4. 1	0	0	26
SE¼ sec. 5, T. 140 N., R. 96 W	(2)	1. 5	9. 6	3. 9	21. 9	42
S½SE¼ sec. 14, T. 138 N., R. 93 W	46, 400	1. 0	5. 4	0	0	25
NW¼ sec. 16, T. 139 N., R. 94 W	405, 000	. 2	6. 4	0	0	14

[1] The size limit of clay in the United States system (below 0.002 millimeter). [2] Unknown.

are subject to streambank cutting and overflow, and the Belfield soils, below a depth of 25 inches, contain salts that affect the properties of the soils. The Colvin, Dimmick, saline phase of the Grail soils, and Saline alluvial land are highly corrosive to pipelines. Wet alluvial land is also likely to be highly corrosive to pipelines where salts are present. The Midway soils contain some salts, and the Wibaux soils contain clinker fragments.

Filter fields for septic tanks.—The proper functioning of the filter field for a septic tank or seepage pit depends mainly on the permeability or percolation rate of the soil and the filtering action that takes place. Water moves faster through a sandy or gravelly soil than through a soil that contains a large amount of clay and fine silt. The permeability rates shown in table 4 can be used as a guide for selecting soils that can be investigated for use as a filter field. Generally, a percolation rate of 1 inch per hour is necessary to provide an adequate filter field. Areas in which the water table is high and also areas that are flooded, that have steep slopes, or that contain layers of rock or compacted soil material are considered inadequate for a filter field for sewage disposal. Agricultural Information Bulletin No. 243, "Soils Suitable for Septic Tank Filter Fields" (*17*), is a valuable source of information on this subject. It also shows how to conduct a percolation test.

Genesis, Classification, and Morphology of Soils

In this section the major factors that influence the development of soils are described. The two systems used in the United States for classifying soils are then briefly defined, the soils are placed in these two systems, and the great soil groups are discussed. Finally, the soil series are discussed in detail and a profile that is representative for each series is described. Laboratory data for representative soils are given in the section "Physical and Chemical Properties of Soils."

Factors of Soil Formation

Soil is produced by the action of soil-forming processes on material deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and existed since accumulation; (3) the plant and animal life on and in the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of soil development have acted on the soil material.

Climate and vegetation are active factors of soil genesis. They act on the parent material that has accumulated through the weathering of rocks and slowly change it to a natural body that has genetically related horizons. The effects of climate and vegetation are conditioned by relief. The parent material also affects the kind of profile that can be formed and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil profile. The amount of time may be much or little, but some time is always required for differentiation of horizons. Usually, a long time is required for the development of distinct horizons. The factors of soil genesis are so closely interrelated in their effects on the soils that few generalizations can be made regarding the effect of any one unless conditions are specified for the other four. Many of the processes of soil development are unknown.

Parent material

The parent material of the soils of this county is of three main types. These are residuum, or material weathered from underlying rocks; alluvium; and colluvium. Glacial till has not affected the formation of the soils, although at some time during the Pleistocene epoch, glaciers modified the northeastern corner of the area that is now Stark County. The thin layer of glacial till that was left was later removed by postglacial erosion. Granitic boulders, left by the glaciers, are the only remaining evidence that glaciers entered the county. Thin deposits

of till are still evident, however, about 20 miles north of the county line.

Residuum.—Many soils of the uplands in Stark County developed in material weathered from soft shale, siltstone, and sandstone. This sedimentary material is highly stratified, and the many layers range from a few feet to 75 feet in thickness. These sediments are considered to be the oldest source of soil parent material in the county. Estimates place their age at 70 million years (*6*). The material that made up the underlying rocks was deposited during the Tertiary period when an inland sea covered this area. Members of three formations of this period—the Fort Union, Golden Valley, and White River—occur in Stark County.

The Fort Union formation is the oldest and most extensive of the three formations from which material has weathered to form soils. The layers in this formation range from 8 to 70 feet in thickness, and the total thickness of the formation ranges from 400 to 600 feet. Olive and gray silty clay shale, pale-olive siltstone, and grayish-brown sandstone alternate throughout the formation, and thick lignite coalbeds are at several different depths. The main soils that developed on beds of siltstone of the Fort Union formation are those of the Morton, Chama, and Bainville series. Those soils are able to store more moisture and they contain a greater supply of plant nutrients than the Vebar, Lihen, and Flasher soils. In the Vebar, Lihen, and Flasher series are the major soils that developed on sandstone strata of the Fort Union formation.

The Golden Valley formation underlies all the area covered by the White River formation, and it extends in all directions beyond the boundary of the area covered by that formation (fig. 18) (*3*). In addition, several strata are within many of the isolated buttes. These strata consist mainly of clay loam shale, loamstone, and sandstone, and there are narrow bands of lignite coal in a few places. Two of the sandstone strata contain a mixture of grains of quartz and kaolinitic clay. The Lefor soils developed in material weathered from those strata. They have low cation-exchange capacity according to laboratory studies of samples taken in the county. This fact is a reasonable explanation for the low fertility of the Lefor soils.

The White River formation is made up of six or seven tan and gray thin layers of clay. It is younger than the Fort Union and Golden Valley formations. It occurs on the summits and upper sides of buttes in a syncline area, at a higher elevation than the other formations. Most of this formation has been removed by geologic erosion, but several kinds of prehistoric fossils of plants and animals have been found in the remaining strata. Many strata of the White River formation have a high content of clay. This accounts for the large proportion of Moreau and Promise soils that occur on this formation.

Alluvium.—This consists of sand, silt, and other particles deposited on land by streams. After the Tertiary period, the residual plains were gradually dissected and eroded by moving water, and a system of natural drainage was established. Soil material carried in suspension by these streams was deposited at various places and formed terraces. As the stream valleys became entrenched, other terraces were formed at a lower elevation.

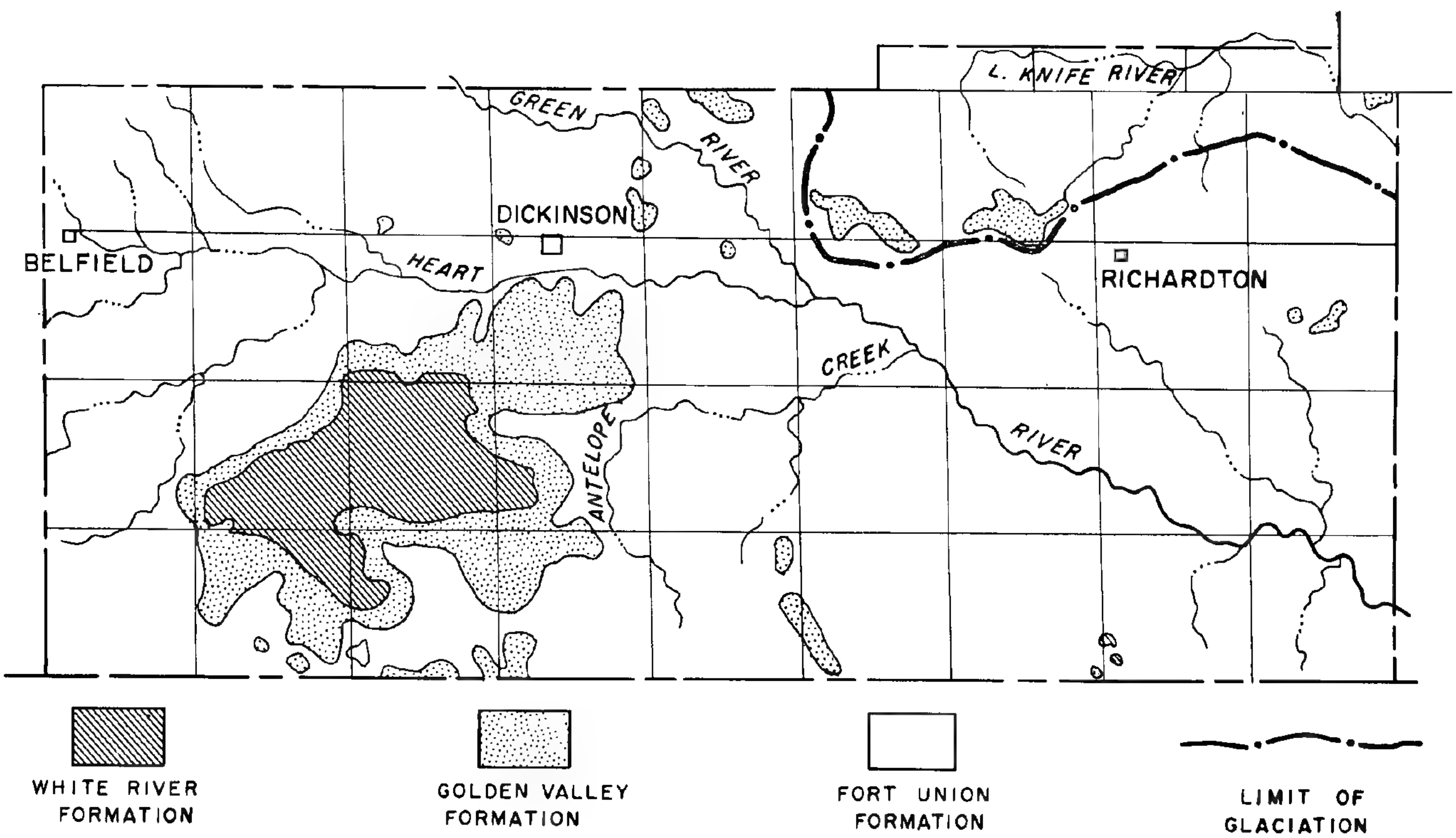

Figure 18.—**Geologic map of Stark County, N. Dak.**

At the present time, recent alluvium is on the bottom lands, and older alluvium is on the crests of each valley escarpment where it was left thousands of years ago. The Havre, Straw, and Glendive soils are examples of soils formed in recent alluvium of the flood plains. The Manning and Farland soils are examples of soils formed in old alluvium on the terraces. Soils formed in this old alluvium, unlike those formed in recent alluvium, normally have a well-developed profile.

Colluvium.—The soils of several series in Stark County formed in material that accumulated as the result of soil creep or slides, or that eroded from higher lying soils and was deposited at the base of slopes a short distance from the uplands. The material ranges from fine sandy loam to silty clay in texture. It has been transported by water or has been moved by gravity to swales and drainageways adjacent to the sloping uplands. The colluvium has gradually accumulated in nearly level and gently sloping, concave areas as a result of geologic erosion. The soils of the Arnegard, Grail, and Cherry series formed in this kind of material.

Climate

In this section climate is described as it affects the formation of soils. Primarily, precipitation, extremes in temperature, and the effects of wind are discussed. More information about this subject is given in the section "Climate" in the back of the report.

Stark County has a semiarid, continental type of climate that varies widely from season to season. The average daily maximum temperature during the warmest months of June, July, and August is 80.3° F., and the average daily minimum temperature during the three coldest months of December, January, and February is 3°. The average annual temperature is 40.3°. The average annual precipitation is 15.5 inches. Most of the precipitation is in the form of rain that falls during the months of May, June, and July.

Climate determines the type of vegetation that successfully survives the variations of heat and cold and of dry and wet weather. It also influences the amount and kinds of physical and chemical weathering of the parent material. Among the physical changes that take place in soil material as the result of climate are the changes brought about by frost and the resulting expansion and contraction caused by changes in temperature. Expansion of the soil material as the result of frost action contributes toward the formation of vertical cracks and fissures in bedded soil material. It also provides a force that breaks down cobbles and stones. Frost penetrates to a depth of 3 to 5 feet during the approximately 120 days that make up the freezing period in this county.

Chemical weathering takes many forms within a soil. Organic matter, for example, oxidizes rapidly when the temperature is high, but little oxidation takes place when the soil is frozen. The product of bacterial action (organic matter) is rapidly destroyed when it is exposed to continuous warm temperatures, but it is allowed to accumulate where the climate includes seasons when little chemical activity takes place. The very dark grayish-brown color of the surface layer of many of the soils of Stark County is caused mainly by the fairly high content of organic matter.

The amount of rainfall not only determines, to a great extent, what kinds and amounts of plants grow in an area, but it also affects the soil profile. Moisture that penetrates into the soil transports fine particles of clay, minerals, and compounds to a greater depth in the soil, a process known as leaching. The effects of leaching are noticeable in many of the soils of this country, especially where lime has accumulated in the lower part of the subsoil or where clay films are on the surfaces of the soil peds. Accumulations of lime in the Cca horizons and clay films along the faces of the prisms and blocks of the B horizons are especially noticeable in the Manning, Morton, Belfield, and Regent soils. Thus climate, through rainfall, determines the amount of plant nutrients that go into solution and that are ultimately leached to a lower level in the profile.

Wind, as one of the forces of climate, has modified most of the soils. The Valentine and Lihen soils show the greatest effects of its activity. The undulating or dunelike relief of those soils indicates severe wind action prior to the time these soils were stabilized by vegetation. Outcrops of sandstone in areas of the Flasher soils continue to be worn down by the action of wind. The material eroded as the result of wind action is usually deposited on adjacent areas in such a thin layer that the accumulation is not noticed. Man, by his activities, has also caused accelerated wind erosion in many places.

Plant and animal life

Short and mid grasses of the semiarid plains have influenced the development of the soils in Stark County as much as any other factor of soil formation. The fibrous root system and decaying leaf blades of these grasses are the main source of organic matter. The soils that formed under a cover of grass are deep, and they have a well-developed profile. Their surface layer is dark colored and friable, and they have a permeable subsoil. The dark color of the surface layer results from an accumulation of organic matter that, in turn, promotes the development of good tilth and good soil structure. The rate at which organic matter accumulates in the surface layer is controlled by the density of the plant cover, by losses through erosion, and by the rate of decomposition.

The decay of the roots and leaves of grasses is a function of the millions of tiny living organisms within each cubic foot of surface soil. These micro-organisms consist of bacteria, fungi, and insects that attack the tissues of the plants and use these materials as food. A part of the products that result from this bacterial action on dead organisms serve as nutrients for present and future plants.

Relief

Relief, through its effects on drainage, runoff, and geologic erosion, has played an important part in the formation of soils in this county. The predominantly gently sloping to strongly sloping relief causes many of the soils to be well drained or excessively drained. Well-drained soils exhibit the maximum and normal characteristics that result from the interaction of the factors of soil formation. To an extent, the opposite is true for both poorly drained and excessively drained soils.

Excessive water in the soil restricts the amount of air that infiltrates. Also, wet soils generally receive deposits of soil material that have been transported by drainage water. Their surface layer is generally high in content

of organic matter because of the abundance of water-tolerant plants they support. In general, the extra moisture and deposits of soil material received by the wet soils are obtained at the expense of excessively drained soils. Good examples of soils formed under poor drainage are those of the Dimmick series.

Runoff is probably the most limiting factor in the development of the excessively drained, strongly sloping and steep soils of the Regosol and Lithosol great soil groups. Profile development has taken place to only a limited extent in those soils, mainly because much of the precipitation runs off and only a small amount enters the soils. The runoff on these soils causes erosion, and the loss of moisture causes the soil material to be dry. Consequently, the cover of plants is sparse, these soils continue to erode and development of the soil profile is restricted.

Not much leaching has taken place in strongly sloping and steep soils. Lime is in the surface layer and is not concentrated below the subsoil, as in well-drained soils.

Time

The length of time the four factors of climate, plant and animal life, parent material, and relief have acted on soil material determines the depth, structural development, amount of leaching of lime and salts, and distinctness of the horizons in the soil profile. Soil scientists describe a soil as young or old, as a result of observations that have been made of the length of time the parent material has been in place and of the length of time relief, vegetation, and climate have affected the development of the soil profile. An old soil is said to be in equilibrium with its environment; the development of greater soil depth and structure has reached a point of balance in such soils. The opposite is true of young, or immature, soils. The soil material has not been in place long enough, and the other factors of soil formation have not had a long enough time to act on the soils, for well-defined horizons to form. As time passes, however, a more distinct surface layer and subsoil develop in many young soils.

The effect of time is often modified by man's activities. Among these activities are tillage, which may cause erosion, and irrigation, which affects drainage and the accumulation of salts.

Among the older soils of this county are those of the Morton and Manning series. The Banks and Glendive soils are examples of young soils in this county. Some of the young soils on the bottom lands of the major streams still receive deposits of fresh material when the areas are flooded.

Classification and Morphology of Soils

Soils are classified so that we may more easily remember their significant characteristics; assemble knowledge about them; see their relationships to one another and to the whole environment; and develop principles that help us understand their behavior and response to manipulation. First, through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

Two systems of natural classification of soils are now in general use in the United States. One of these is the 1938 system, with later revisions (*2*, *14*). The other, a completely new system, was placed in general use by the Soil Conservation Service at the beginning of 1965 (*12*, *16*).

The 1938 system, with later revisions, consists of six categories. In the highest of these, soils of the whole country have been place into three orders. The next two categories, the suborder and family, have not been fully developed. As a consequence, they have not been used much. Attention has been centered on lower categories, the great soil group, the soil series, and the soil type. A further subdivision of the soil type, called the soil phase, has been clearly defined, along with soil type and soil series, in the section "How this Survey Was Made" in the front of this report. In this report the 1938 system, with later revisions, is explained more fully than the new system.

In the highest category of the 1938 classification system are the zonal, intrazonal, and azonal orders. The zonal order consists of soils with evident, genetically related horizons that reflect in their formation the dominant influences of climate and living organisms, chiefly vegetation. Typical zonal soils have a thick, black A1 horizon that has weak granular structure. In most of the zonal soils of this county, a horizon of lime accumulation, the Cca horizon, underlies the B horizon.

In the intrazonal order are soils that have evident, genetically related horizons that reflect the dominant influence of some local factor of relief, drainage, or parent material over the influences of climate and vegetation.

The azonal order consists of soils that lack distinct, genetically related horizons, generally because of youth, resistant parent material, or steep relief.

The classification of the soil series of Stark County into orders and great soil groups under the 1938 classification system is shown in the following tabulation:

Order and great soil group	*Series*
Zonal—	
Chestnut soils	Arnegard, Chama, Cherry, Farland, Grail, Lefor, Lihen,[1] Little Horn,[2] Manning, Moreau, Morton, Parshall, Promise,[3] Regent, Savage, Searing, Straw, Vebar.
Intrazonal—	
Humic Gley soils	Dimmick.
Solonchak	Colvin.
Solodized-Solonetz	Beckton, Belfield, Hoven, Rhoades.
Azonal—	
Alluvial soils	Banks, Gallatin, Glendive, Havre.
Lithosols	Bainville, Duncom, Midway, Wibaux.
Regosols	Flasher, Valentine.

[1] Intergrading toward the Regosol great soil group.
[2] Intergrading toward the Chermozem great soil group.
[3] Intergrading toward the Grumusol great soil group.

The new system of soil classification recently adopted by the Soil Conservation Service also contains six categories. They are, beginning with the most inclusive, the order, suborder, great group, subgroup, family, and series

(*12*). Of the ten orders in the system, only three are represented in Stark County. They are the Entisols, Aridisols, and Mollisols.

In this system the criteria used as bases for classification are observable or measurable soil properties. The properties are so chosen, however, that soils of similar genesis or mode of origin are grouped together.

In the following paragraphs the great soil groups of the 1938 classification system are defined. Each soil series in the great group has also been tentatively placed in a subgroup and family of the new comprehensive system.

Chestnut soils

The Chestnut great soil group consists of a group of soils that have a dark-brown surface horizon, high in content of organic matter, that grades to lighter colored horizons. These soils have a friable surface layer that generally has crumb structure. They have a distinct subsoil that has been modified by roots and by percolating soil moisture. Lime has accumulated at a depth of 1 to 4 feet. In most of the Chestnut soils of Stark County, accumulated lime is at a depth between 15 and 24 inches, but it has leached to a depth of 3 to 4 feet in some places. In general the soils of this great group formed under mixed tall and short grasses, but in Stark County they formed under mixed short and mid grasses. The climate in which they formed is sub-humid to semiarid and temperate to cool-temperate.

The following are the soil series in the Chestnut great soil group. Also named are the subgroups and families in the new comprehensive system in which each series has been tentatively classified:

Soil series	*Subgroup in the new comprehensive system*	*Family in the new comprehensive system*
Arnegard	Cumulic Haplustolls.	Fine loamy, mixed, frigid.
Chama	Typic Calciustolls.	Fine silty, mixed, frigid.
Cherry	Mollic Camborthids.	Fine loamy, mixed, frigid.
Farland	Typic Argiustolls.	Fine loamy, mixed, frigid.
Grail	Cumulic Argiustolls.	Fine, mixed, frigid.
Lefor	Typic Argiustolls.	Fine loamy, mixed, frigid.
Lihen [1]	Cumulic Haplustolls.	Sandy, mixed, frigid.
Little Horn [2]	Typic Argiustolls.	Fine silty, mixed, frigid.
Manning	Typic Haplustolls.	Fine loamy over sandy skeletal, frigid.
Moreau	Typic Haplustolls.	Fine montmorillonitic, frigid.
Morton	Typic Argiustolls.	Fine silty, mixed, frigid.
Parshall	Cumulic Haplustolls.	Coarse loamy, mixed, frigid.
Promise [3]	Cumulic Haplustolls.	Fine montmorillonitic, frigid.
Regent	Typic Argiustolls.	Fine, mixed, frigid.
Savage	Typic Argiustolls.	Fine, mixed, frigid.
Searing	Typic Haplustolls.	Fine silty, mixed, frigid.
Straw	Cumulic Haplustolls.	Fine loamy, mixed, frigid.
Vebar	Typic Haplustolls.	Coarse loamy, mixed, frigid.

See footnotes at end of list.

[1] Intergrading toward the Regosol great soil group.
[2] Intergrading toward the Chernozem great soil group.
[3] Intergrading toward the Grumusol great soil group.

Humic Gley soils

The Humic Gley great soil group consists of poorly drained or very poorly drained soils that have a thick, black A horizon, high in content of organic matter, over a gray or mottled B or C horizon. These soils formed under marsh plants or swamp forest in a subhumid, cool-temperate to warm-temperate climate. In Stark County they occur in shallow basins, mainly in the uplands. Lime has been leached down to the lower part of their subsoil.

In this county only the Dimmick series is in the Humic Gley great soil group. The Dimmick series has been tentatively classified in the Cumulic Haplaquolls subgroup of the new comprehensive system and in the fine, montmorillonitic, noncalcareous, frigid family.

Solonchak soils

In the Solonchak great soil group are soils in which the morphology has been severely influenced by the content of calcium carbonate and salts. In this county these soils are poorly drained because of a high water table that has deposited lime and salts near the surface. Carbonates have been brought to the upper part of the profile through capillary action. This has exceeded downward movement by leaching. These soils are normally light colored and are generally without characteristic structural form. The Solonchak soils of Stark County, however, have a dark-colored surface layer that has granular structure. Beneath the surface layer is light-colored, limy, dense soil material. These soils formed under salt-tolerant grasses or forbs, mostly in an arid, semiarid, or subhumid climate.

In this county the only soil series in the Solonchak great soil group is the Colvin. The Colvin series has been tentatively classified in the Typic Calciaquolls subgroup of the new comprehensive system and in the fine silty, mixed, frigid family.

Solonetz soils

The soils of the Solonetz great soil group have a surface horizon of variable thickness, underlain by a dense B horizon that has columnar structure. The B horizon is clay enriched, and the peds are commonly coated with dark-colored clay films. These soils have a large concentration of saline-alkali salts in their subsoil and sub-

stratum. In the upper B horizon or within 6 inches of the surface, the content of exchangeable sodium exceeds 15 percent. This accounts for the dispersion and crusting of the A1 horizon in the Rhoades and Hoven soils. The Belfield soils have only a small amount (0.2 to 5 percent) of sodium in both the A and B horizons, but the concentration of sodium and of other salts increases greatly in the substratum.

The following are the soils of Stark County that are in the Solonetz great soil group but that are intergrading toward the Soloth great soil group. Also named are the subgroups and families in the new comprehensive system into which each series has been tentatively classified:

Soil series	*Subgroup in the new comprehensive system*	*Family in the new comprehensive system*
Beckton	Typic Natrustolls.	Fine, mixed, frigid.
Belfield	Glossic Natrustolls.	Fine, mixed, frigid.
Hoven	Typic Natraquolls.	Fine, montmorillonitic, frigid.
Rhoades	Mazic Natrustolls.	Fine, montmorillonitic, frigid.

Alluvial soils

In the Alluvial great soil group are deep, nearly level soils that consist of transported and relatively recently deposited material. These soils are on the flood plains of streams and are subject to additional deposition. They are characterized by a weak modification, or no modification, of the original material by soil-forming processes. The dark color of the surface layer of some of them is mainly inherited from the parent material and is not the result of soil genesis.

The following are the soil series in the Alluvial great soil group. Also named are the subgroups and families in the new comprehensive system to which each series has been tentatively classified:

Soil series	*Subgroup in the new ccmprehensive system*	*Family in the new comprehensive system*
Banks	Typic Ustifluvents.	Sandy, mixed, frigid.
Gallatin	Aquic Ustifluvents.	Fine loamy, mixed, frigid.
Glendive	Tpyic Ustifluvents.	Coarse loamy, mixed, calcareous, frigid.
Havre	Typic Ustifluvents.	Fine loamy, mixed, calcareous, frigid.

Lithosols

Lithosols are a group of soils that have no clearly expressed soil morphology and have a restrictive layer near the surface. Profile development has been limited to the formation of a thin surface layer. The restrictive layer is bedrock or coarser material that permits little or no penetration of roots. These soils are mainly strongly sloping or steep. The rate of runoff is high, and a large amount of soil material is lost through erosion.

The following are the soil series in the Lithosol great soil group. Also named are the subgroups and families in the new comprehensive system to which each series has been tentatively classified:

Soil series	*Subgroup in the new comprehensive system*	*Family in the new comprehensive system*
Bainville	Typic Ustorthents.	Fine silty, mixed, calcareous, frigid.
Duncom	Lithic Haplustolls.	Fine silty, mixed, frigid.
Midway	Typic Ustorthents.	Fine, mixed, calcareous, frigid.
Wibaux	Lithic Ustorthents.	Fine loamy, mixed, frigid.

Regosols

Regosols are a group of soils that lack definite genetic horizons and that developed in deep unconsolidated or soft rocky deposits. Development of a distinct profile has been retarded, mainly by losses through erosion and droughtiness. In this county the material in which these soils developed is sand and soft sandstone.

The following are the soil series in the Regosol great soil group. Also named are the subgroups and families in the new comprehensive system to which each series has been tentatively classified:

Soil series	*Subgroup in the new comprehensive system*	*Family in the new comprehensive system*
Flasher	Entic Haplustolls.	Sandy, mixed, frigid, thin.
Valentine	Typic Normipsamments.	Sandy, siliceous, nonacid, frigid.

Descriptions of the soil series

In the following pages the soil series in the county are described in alphabetical order. For each series, a detailed description of a representative profile is given.

Arnegard Series

In the Arnegard series are deep, dark-colored, well-drained Chestnut soils that have a medium-textured or moderately fine textured solum. These soils developed in local alluvium washed from adjacent fine sandy loams and other loamy soils of the uplands. They are on concave slopes in drainageways or swales and are also on toe slopes. They receive extra water from runoff. The slopes range from 0 to 6 percent.

The Arnegard soils are darker colored, have thicker A and B horizons, and contain less sand than the Vebar and Parshall soils. They are darker colored and have thicker horizons than the Morton soils. The Arnegard soils are less clayey than the Grail soils, though the soils of the two series occur in similar areas.

Typical profile of Arnegard silt loam, 300 feet south and 0.35 mile east of the northwest corner of section 5, T. 139 N., R. 94 W. (Sample No. S-58-ND-45-15, Laboratory No. 8578-86: See the section "Physical and Chemical Properties of Soils"):

Ap—0 to 5 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) when moist; uppermost 1 inch has moderate platy structure; lower part has moderate, fine and medium crumb structure; slightly hard when dry, very friable when moist, slightly sticky and slightly

plastic when wet; noncalcareous; abrupt, smooth boundary.

A1—5 to 11 inches, very dark gray (10YR 3/1) loam, black (10YR 2/1) when moist; weak, medium prismatic structure but breaks to moderate, medium, angular blocky structure; hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; clear, wavy boundary.

B21—11 to 20 inches, dark grayish-brown (2.5Y 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, coarse, prismatic structure but breaks to moderate, medium, angular blocky structure; hard when dry, friable when moist, slightly sticky and plastic when wet; clay skins on the tops and vertical surface of the prisms; noncalcareous; gradual, smooth boundary.

B22—20 to 29 inches, dark grayish-brown (2.5Y 4/2) sandy clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, coarse, prismatic structure but breaks to moderate, medium, angular blocky structure; hard when dry, friable when moist, slightly sticky and plastic when wet; clay skins on all the surfaces of the peds; noncalcareous; clear, smooth boundary.

B3—29 to 37 inches, dark grayish-brown (2.5Y 4/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate, coarse, prismatic structure but breaks to moderate, medium, angular blocky structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; clay skins on all the surfaces of the peds; noncalcareous; abrupt, smooth boundary.

Ab—37 to 43 inches, dark grayish-brown (2.5Y 4/2) loam, black (10YR 2/1) when moist; weak, coarse, prismatic structure but breaks to moderate, medium, subangular blocky structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; clay skins on all the surfaces of the peds; noncalcareous; abrupt, smooth boundary.

Bb1—43 to 48 inches, dark grayish-brown (2.5Y 4/2) sandy clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, prismatic structure but breaks to moderate, medium, angular blocky structure; very hard when dry, friable when moist, slightly sticky and plastic when wet; very dark brown (10YR 2/2) clay skins on all the surfaces of the peds; calcareous; abrupt, smooth boundary.

Bb2—48 to 53 inches, olive-brown (2.5Y 4/4) sandy clay loam, dark grayish brown (2.5Y 4/2) when moist; other characteristics same as those in the Bb1 horizon.

C1—53 to 64 inches, olive-brown (2.5Y 4/4) loamy fine sand, olive brown (2.5Y 4/3) when moist; single grain; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; noncalcareous.

The color of the A1 horizon ranges from very dark gray to very dark grayish brown when dry and from black to very dark gray when moist. In places the texture of the A1 horizon is silt loam instead of loam. The thickness of the surface layer ranges from 7 to 18 inches. The texture of the B2 and B3 horizons ranges from loam or clay loam to sandy loam, and the combined thickness of those horizons ranges from 26 to 40 inches. Their color ranges from dark grayish brown or very dark grayish brown to dark brown. Where a C horizon occurs, its texture is loam or sandy clay loam in most places, but the texture is fine sandy loam or loamy fine sand in a few places in the C horizon.

Bainville Series

The soils of the Bainville series are excessively drained Lithosols that developed in material weathered from calcareous, loamy, soft shale. These soils lack a well-defined profile. Their profile has a thin, slightly darkened A1 horizon that rests on a weakly defined Cca horizon on partly weathered shale. Beneath the Cca horizon is stratified shale that has a texture of very fine sandy loam, loam, or silt loam. These soils are on the crests of hills and ridges and on the upper part of slopes in the uplands. They are sloping to steep.

The Bainville soils occur with the Morton, Chama, and Rhoades soils, and in many parts of the county they occur in undifferentiated units with the Midway soils. They have a thinner, lighter colored A horizon than the Chama and Morton soils, and unlike those soils, they lack a B horizon. Also, they have a less well-defined Cca horizon and have stratified shale nearer the surface. The Bainville soils lack the A2 horizon that is typical in the profile of the Rhoades soils, they lack a B horizon that has strong columnar structure, and they also lack salts in their C horizon. In contrast to the Midway soils, the Bainville soils developed in material weathered from loamy shale.

Typical profile of Bainville loam, 220 rods east and 140 rods south of the W¼ corner of section 28, T. 140 N., R. 92 W. (Sample No. S-58-ND-45-12, Laboratory No. 8554-61: See the section "Physical and Chemical Properties of Soils"):

A1—0 to 2 inches, dark grayish-brown (2.5Y 4/2) loam, very dark brown (10YR 2/2) when moist; weak, fine, crumb structure; slightly hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; calcareous; clear, smooth boundary.

ACca—2 to 6 inches, olive-gray (5Y 5/2) silt loam, olive (5Y 4/3) when moist; moderate, medium, crumb structure, slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; very strongly calcareous; gradual, wavy boundary.

Cca—6 to 12 inches, pale-yellow (5Y 7/3) silt loam, olive (5Y 5/4) when moist; moderate, medium, platy and moderate, medium, angular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; very strongly calcareous and contains a few nodules of lime; gradual, wavy boundary.

C1—12 to 18 inches, pale-yellow (5Y 7/4) silt loam, olive (5Y 5/3) when moist; strong, fine and medium, platy structure; hard when dry, friable when moist, sticky and plastic when wet; strongly calcareous; abrupt, smooth boundary.

C2—18 to 34 inches, white (5Y 8/2) silt loam, olive gray (5Y 5/2) when moist; strong, medium, platy structure; hard when dry, firm when moist, slightly sticky and plastic when wet; strongly calcareous; abrupt, smooth boundary.

C3—34 to 41 inches, pale-yellow (5Y 8/4) silt loam, olive gray (5Y 5/2) when moist; strong, very thick platy structure; between the structural peds has thin layers of very fine sand that are light gray (5Y 6/1) when moist; very hard when dry, firm when moist, sticky and plastic when wet; strongly calcareous; abrupt, smooth boundary.

C4—41 to 56 inches, pale-yellow (5Y 7/4) silty clay loam, olive (5Y 5/4) when moist; strong, very thick, platy structure; extremely hard when dry, very firm when moist, sticky and plastic when wet; strongly calcareous; abrupt, smooth boundary.

C5—56 to 59 inches, pale-yellow (5Y 7/3) very fine sandy loam, light olive gray (5Y 6/2) when moist; weak, very thin, platy structure; very friable when moist, nonsticky and nonplastic when wet; strongly calcareous.

The texture of the A1 horizon ranges from very fine sandy loam to light clay loam, and the thickness of the A1 horizon ranges from 2 to 5 inches. The color of the substratum ranges from pale yellow, white, or pale olive

to dark gray. The texture of the stratified material that makes up the substratum ranges from fine sandy loam to light clay loam, and this material ranges from weakly calcareous to very strongly calcareous.

Banks Series

In the Banks series are young, excessively drained soils of the Alluvial great soil group. These soils developed in sandy alluvium on flood plains. The areas are adjacent to the present channel of the Heart River. These soils are gently undulating and have slopes of 1 to 5 percent. They are light colored and have weakly defined horizons. Below the surface layer, the profile is stratified and contains alternate strata of loamy sand, sand, and sandy loam. Pieces or fragments of lignite and porcelanite are common throughout the profile.

The Banks soils occur with the Havre and Glendive soils, but they are coarser textured than those soils. They are more stratified and lack the B horizon that is characteristic of the Lihen soils. Also, they formed in recently deposited material and are subject to overflow. The Banks soils are coarser textured and have looser consistence than the Flasher soils.

A typical profile of Banks loamy sand, 700 feet east and 1,260 feet north of the southwest corner of the northwest quarter of section 19, T. 138 N., R. 92 W.:

1—0 to 4 inches, grayish-brown (2.5Y 5/2) loamy sand, dark grayish brown (2.5Y 4/2) when moist; weak, fine, subangular blocky structure to single grain; soft when dry, loose when moist, nonsticky and nonplastic when wet; noncalcareous; abrupt, smooth boundary.

2—4 to 10 inches, grayish-brown (2.5Y 5/2) fine sandy loam, very dark grayish brown (2.5Y 3/2) when moist; moderate, coarse and medium, subangular blocky structure; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; slightly calcareous; abrupt, wavy boundary. (Separated from horizon 3 by a layer of medium sand about three-fourths of an inch thick.)

3—10 to 16 inches, grayish-brown (2.5Y 5/2) sandy loam, very dark grayish brown (2.5Y 3/2) when moist; moderate, coarse and medium, angular blocky structure; very friable when moist, nonsticky and nonplastic when wet; noncalcareous; abrupt, smooth boundary.

4—16 to 54 inches, grayish-brown (2.5Y 5/2) medium sand, dark grayish brown (2.5Y 4/2) when moist; single grain; loose when moist, nonsticky and nonplastic when wet; noncalcareous.

The surface layer ranges from 3 to 12 inches in thickness. The texture of the surface layer ranges from loamy fine sand to medium sand. The thickness of the individual horizons in the substratum ranges from less than 1 inch to 40 inches. In many places the profile is noncalcareous throughout, but it contains slightly calcareous layers in other places.

Beckton Series

The soils of the Beckton series are moderately well drained solodized-Solonetz soils developed in windblown, moderately sandy deposits over soft alkaline shale. They occur in scattered areas in the uplands and on high stream terraces.

The profile consists of an A1 horizon of grayish-brown or very dark grayish-brown fine sandy loam, an A2 horizon of grayish-brown fine sandy loam, and a B2 horizon of sandy clay that has coarse columnar structure. An abrupt boundary separates the A2 and B2 horizons, and a sequence of Bcs, Ccs, or Ccsca horizons underlie the B2 horizon. The substratum is from the bedded, clayey shale of the Fort Union formation.

Unlike the Belfield soils, which have an A horizon of loam or silty clay loam, the Beckton soils have an A horizon of fine sandy loam. They also have a dense B horizon that has columnar instead of prismatic structure. The Beckton soils have a thicker solum than the Rhoades soils.

Typical profile of Beckton fine sandy loam, in a cultivated field 145 feet south and 630 feet west of the northeast corner of section 1, T. 137 N., R. 99 W.:

A1p—0 to 8 inches, dark grayish-brown (2.5Y 4/2) fine sandy loam, very dark grayish brown (2.5Y 3/2) when moist; moderate, coarse and fine, subangular blocky structure; soft when dry, friable when moist, nonsticky and nonplastic when wet; noncalcareous; abrupt, smooth boundary.

A2—8 to 9 inches, grayish-brown (2.5Y 5/2) fine sandy loam, dark grayish brown (2.5Y 4/2) when moist; weak, thin, platy structure to single grain; soft when dry, friable when moist, nonsticky and nonplastic when wet; noncalcareous; abrupt, smooth boundary.

IIB2—9 to 16 inches, dark grayish-brown (2.5Y 4/2) sandy clay, very dark grayish brown (2.5Y 3/2) when moist; strong, coarse, columnar structure but breaks to moderate, coarse, angular blocky structure; extremely hard when dry, very firm when moist, sticky and plastic when wet; noncalcareous; clear, wavy boundary.

IIBca—16 to 20 inches, olive-gray (5Y 4/2) silty clay, dark olive gray (5Y 3/2) when moist; strong, very coarse, prismatic structure but breaks to moderate angular blocky structure; extremely hard when dry, firm when moist, sticky and plastic when wet; strongly calcareous and contains many nests of salt crystals; the surfaces of the prisms are thickly coated with sand grains; gradual, wavy boundary.

IICcs—20 to 39 inches, greenish-gray (5G 6/1) clay, dark olive gray (5Y 3/2) when moist; moderate, coarse and medium, angular blocky structure; extremely hard when dry, firm when moist, very sticky and very plastic when wet; strongly calcareous and contains many white salt crystals; gradual boundary.

IIC1—39 to 46 inches, greenish-gray (5GY 6/1) clay, olive gray (5Y 4/2) when moist; bedded, platy shale; very hard when dry, firm when moist, very sticky and very plastic when wet; calcareous.

IIC2—46 to 56 inches, greenish-gray (5GY 6/1) clay, olive gray (5Y 4/2) and dark gray (5Y 4/1) when moist; massive; very hard when dry, firm when moist, very sticky and very plastic when wet; weakly calcareous.

The A1 or A1p horizon ranges from 6 to 13 inches in thickness. In places its texture is sandy loam instead of fine sandy loam. The A2 horizon ranges from 1 to 5 inches in thickness. The texture of the IIB2 horizon ranges from sandy clay loam to silty clay, and in places the structure of that horizon is very coarse columnar. Depth to salty material ranges from 16 to 30 inches.

Belfield Series

In the Belfield series are well-drained soils that are medium textured and moderately fine textured. These soils are degraded solodized-Solonetz soils in the Chestnut soil zone. They developed partly in stratified silty and clayey material weathered from shale of the Fort Union formation. They also developed in alluvium washed from soils derived from this shale. Their slopes range from 1 to 8 percent but are mainly between 2 and 5 percent. Permeability is moderately slow in the lower part of the profile.

The Belfield soils occur in all parts of Stark County with the Morton, Farland, and Regent soils. Unlike these associated soils, they have a weak or thin A2 horizon, and they contain less clay than the Regent soils. They have a thicker A1 horizon than the Rhoades soils, have prismatic instead of columnar structure, and have salts much deeper in the profile. The Belfield soils differ from the Cresbard soils of the eastern part of North Dakota by having a grayish brown, instead of a very dark brown or black, A1 horizon. They also have a less distinct A2 horizon and coarser prismatic structure in the B2 horizon.

Typical profile of Belfield silt loam in native grass, 320 feet west and 235 feet north of the southeast corner of the southwest quarter of section 36, T. 137 N., R. 98 W.:

A1—0 to 3 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, thin, platy structure; slightly hard when dry, friable when moist, slightly sticky and plastic when wet; noncalcareous; clear, smooth boundary.

A12—3 to 9 inches, grayish-brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; compound moderate, medium, prismatic to weak, fine, subangular blocky structure; very hard when dry, friable when moist, slightly sticky and slightly plastic when wet; continuous clay films and common clean sand grains on the surfaces of the peds; many very fine pores; noncalcareous; clear, wavy boundary.

B2 & A2—9 to 11 inches, grayish-brown (2.5Y 5/2, crushed) silty clay loam, very dark grayish brown (10YR 3/2) when moist; compound moderate, medium, prismatic and strong, very fine, angular blocky structure; the blocks are arranged in weak, medium plates in the prisms; very hard when dry, friable when moist, slightly sticky and slightly plastic when wet; continuous coatings of clean sand grains, one or more grains thick, on the tops of the plates, and abundant coatings of clean sand grains on the sides of the prisms and on the undersides of the plates; the coatings of clean sand constitute the A2 horizon; thin continuous clay films on the undersides of the plates; many very fine pores; noncalcareous; clear, smooth boundary.

B21—11 to 14 inches, grayish-brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) when moist; compound strong, medium, prismatic and strong, medium and fine, angular blocky structure; extremely hard when dry, friable when moist, sticky and plastic when wet; thin continuous clay films and clean sand grains coat the peds; common fine and many very fine pores; noncalcareous; gradual, wavy boundary.

B22—14 to 17 inches, light olive-brown (2.5Y 5/3) silty clay, dark grayish brown (2.5Y 4/2) when moist; compound strong, medium, prismatic and strong, medium and fine, angular blocky structure; extremely hard when dry, friable when moist, sticky and plastic when wet; continuous, thin, dark grayish-brown (2.5Y 4/3) clay films and a few clean sand grains coat the peds; common fine and many very fine pores; noncalcareous; gradual, wavy boundary.

B23—17 to 24 inches, light olive-brown (2.5Y 5/3) heavy silty clay loam, dark grayish brown (2.5Y 4/2) when moist; compound moderate, medium, prismatic and moderate, medium and fine, angular blocky structure; very hard when dry, friable when moist, slightly sticky and slightly plastic when wet; continuous clay films on the surfaces of the peds; many fine and very fine pores; noncalcareous; clear, wavy boundary.

B3ca—24 to 31 inches, grayish-brown (2.5Y 5/2) heavy silty clay loam, dark grayish brown (2.5Y 4/2) when moist; compound moderate, medium, prismatic and weak, medium, angular blocky structure; very hard when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous with common threads of segregated lime; clear, wavy boundary.

C1ca—31 to 43 inches, light brownish-gray (2.5Y 6/2) light silty clay with white (2.5Y 8/2) mottles of lime, dark grayish brown (2.5Y 4/2) and light brownish gray (2.5Y 6/2) when moist; compound moderate, medium, prismatic and weak, medium, angular blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; many fine pores; very strongly calcareous and contains common threads and films of segregated lime; gradual, wavy boundary.

C2ca—43 to 53 inches, light olive-brown (2.5Y 5/3) light silty clay with white (2.5Y 8/2) mottles of lime, olive brown (2.5Y 4/3) and light brownish gray (2.5Y 6/2) when moist; compound moderate, medium, prismatic and weak, medium, angular blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; many fine pores; very strongly calcareous and contains common threads and prominent films of segregated lime; gradual boundary.

C—53 to 59 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) and light brownish gray (2.5Y 6/2) when moist; massive; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous; contains common threads and films of segregated lime and common nests of gypsum crystals.

The A1 horizon ranges from loam or silt loam to silty clay loam in texture and from 6 to 11 inches in thickness. In places the structure of the A1 horizon is granular, fine, blocky, or prismatic. In some places there is a very thin A2 horizon; the coatings of clear sand on the tops of the prisms in the B2 horizon constitute the A2 horizon. The texture of the B horizons ranges from clay loam to silty clay, and the combined thickness of the B2 horizons ranges from 12 to 24 inches. Depth to the zone where lime has accumulated ranges from 20 to more than 36 inches.

Chama Series

The Chama series consists of medium-textured minimal Chestnut soils developed in calcareous silty material and in very fine sandy loam weathered from limy silty shale. These soils have a dark grayish-brown, friable A horizon; a thin, weakly defined, calcareous B horizon that has weak prismatic structure and lacks evident clay films; and a horizon of lime accumulation above the stratified underlying material.

The Chama soils have a darker colored, thicker A horizon than the Bainville soils, and they have a B horizon and a prominent Cca horizon that are lacking in the Bainville soils. They are silt loams instead of silty clays like the Moreau soils. The Chama soils lack the moderately sandy texture of the Vebar soils. They have a thinner A horizon than the Morton soils, and they have lime higher in the profile than have the Morton and Farland soils. Unlike the Morton and Farland soils, they lack a B2t horizon. The Chama soils are finer textured and have a thicker solum than the Flasher soils.

Typical profile of Chama silt loam, 70 rods west and 92 rods south of the northeast corner of section 19, T. 139 N., R. 98 W.:

A1—0 to 6 inches, dark grayish-brown (10YR 4/2) silt loam, very dark gray (10YR 3/1) when moist; weak, fine, subangular blocky to moderate, coarse and medium, crumb structure; slightly hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; slightly calcareous.

Bca—6 to 16 inches, grayish-brown (2.5Y 5/2) silt loam, dark grayish brown (2.5Y 4/2) when moist; weak, coarse and medium, prismatic to moderate, medium, angular blocky structure; slightly hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous; clear, wavy boundary.

Cca—16 to 31 inches, pale-olive (5Y 6/3) silt loam, olive (5Y

5/3) when moist; moderate, coarse, angular blocky to weak, medium, platy structure; same consistence as that in the Bca horizon; very strongly calcareous and contains common, prominent, fine nodules of lime; gradual boundary.

IIC—31 to 48 inches, pale-olive (5Y 6/3) silty clay loam, olive (5Y 5/3) when moist; sedimentary beds that have moderate, medium and thin, platy structure; hard when dry, firm when moist, slightly plastic and slightly sticky when wet; calcareous.

The texture of the A1 horizon ranges from very fine sandy loam to silt loam. The A1 horizon is slightly calcareous in some profiles. The Bca horizon ranges from 3 to 12 inches in thickness.

Cherry Series

In the Cherry series are Chestnut soils that have a weakly developed profile and that formed in moderately fine textured local alluvium. These soils are well drained. They are on colluvial foot slopes and fans below the steep Bainville and Midway soils, mainly along the Heart River. The slopes are concave and range from 4 to 12 percent. Most of the slopes are between 6 and 8 percent.

The Cherry soils are lighter colored, have a less well developed profile, and have lime higher in the profile than the Grail, Regent, Savage, and Morton soils, which are medial soils of the Chestnut great soil group. Unlike the Bainville and Midway soils, they have a B2 horizon. The Cherry soils are finer textured than the Havre soils, and they have a thicker, more strongly developed profile than the Havre soils.

Profile of Cherry silty clay loam in native prairie, 427 feet east of the southwest corner of section 5, T. 138 N., R. 93 W.:

A1—0 to 3 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; moderate, medium, subangular blocky and moderate, fine, crumb structure; hard when dry, friable when moist, sticky and plastic when wet; noncalcareous; abrupt, smooth boundary.

B21—3 to 15 inches, grayish-brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) when moist; moderate, coarse, prismatic and moderate, fine and medium, angular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; strongly calcareous and contains many fine, white threads of lime; has common patches of clay films on the vertical and horizontal surfaces of the peds; gradual, wavy boundary.

B22—15 to 33 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; weak, coarse, prismatic and strong, fine and medium, angular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; calcareous and has many fine, white threads and a few nodules of segregated lime; common patches of clay films on the vertical and horizontal surfaces of the peds; gradual, wavy boundary.

C1—33 to 50 inches, olive-gray (5Y 5/2) silty clay, olive gray (5Y 4/2) when moist; moderate, fine and medium, angular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; strongly calcareous.

C2—50 to 58 inches (auger sample); olive (5Y 5/3) silty clay, olive gray (5Y 4/2) when moist; hard when dry, friable when moist, sticky and plastic when wet; strongly calcareous.

The thickness of the A1 horizon ranges from 2 to 5 inches. The structure of the B2 horizons ranges from weak to moderate prismatic, and the texture of those horizons ranges from silty clay loam to silty clay. The combined thickness of the B2 horizons ranges from 25 to 33 inches. Depth to lime ranges from 0 to 12 inches. In many places a Cca horizon occurs immediately below the solum. In many places the lower part of the profile contains buried A horizons.

Colvin Series

The Colvin series is made up of medium-textured and moderately fine textured soils of the Solonchak great soil group; they developed in local alluvium. These soils are poorly drained and have a high water table. In most areas their substratum is gleyed and is mottled with yellow, red, and brown. These soils contain a large amount of calcium carbonate. In most places their substratum contains many small and large nodules of lime.

The Colvin soils occur with the Grail, Arnegard, and Farland soils. They are more poorly drained, however, and contain more lime than those soils, and they also lack the distinct horizons typical of those soils. They are less clayey and contain more calcium carbonate than the Hoven and Dimmick soils, and they have a high water table instead of water ponded on the surface.

Profile of Colvin silt loam in native grass prairie, 35 feet north and 0.07 mile west of the southeast corner of the northeast quarter of section 26, T. 139 N., R. 95 W.:

A1—0 to 4 inches, very dark gray (2.5Y 3/0) silt loam, black (2.5Y 2/0) when moist; weak, fine, subangular blocky and moderate, medium, crumb structure; slightly hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; slightly calcareous; gradual, smooth boundary.

A1ca—4 to 11 inches, very dark gray (5Y 3/1) silt loam, black (5Y 2/1) when moist; weak, coarse, prismatic to moderate, coarse and medium, angular blocky structure; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; moderately calcareous; clear, wavy boundary.

IICca—11 to 19 inches, dark-gray (5Y 4/1) silty clay loam, very dark gray (5Y 3/1) when moist; weak, medium, prismatic and moderate, fine and medium, angular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; strongly calcareous; gradual, wavy boundary.

IIC1—19 to 33 inches, light-gray (2.5Y 7/2 and 7/1) silty clay loam, grayish brown (2.5Y 5/2) when moist; massive; slightly hard when dry, firm when moist, sticky and plastic when wet; strongly calcareous; gradual, wavy boundary.

IIC2—33 to 39 inches, light-gray (2.5Y 7/2) silty clay loam, grayish brown (2.5Y 5/2) when moist; massive; hard when dry, firm when moist, sticky and plastic when wet; slightly calcareous.

IIIC3g—39 to 54 inches, light-gray (2.5Y 7/2), light yellowish-brown (2.5Y 6/4), and yellowish-brown (10YR 5/6) sandy clay loam, olive brown (2.5Y 4/4) and yellowish brown (10YR 5/6) when moist; massive; hard when dry, firm when moist, slightly sticky and slightly plastic when wet; slightly calcareous.

The combined A horizons range from 8 to 18 inches in thickness. The texture of the IICca horizon ranges from silt loam to silty clay loam. Beneath the IICca horizon are several horizons that range from sandy loam to silty clay loam in texture.

Dimmick Series

In the Dimmick series are poorly drained Humic Gley soils that developed in clay-filled basins. They are on the uplands and on some of the older terraces along the Knife River.

The Dimmick soils are more poorly drained than the Hoven soils of the Solonetz great soil group. They are more clayey than the Colvin soils and are noncalcareous. Also, they have water ponded on the surface instead of having a fluctuating high water table.

Profile of Dimmick silty clay loam, 65 feet east and 275 feet south of the northwest corner of the southwest quarter of section 33, T. 139 N., R. 96 W.:

- **A1**—0 to 4 inches, dark-gray (10YR 4/1) silty clay loam, very dark brown (10YR 2/2) when moist; moderate, fine and medium, granular structure; very friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; clear, smooth boundary.
- **IIB1g**—4 to 19 inches, gray (10YR 5/1) sandy clay, very dark grayish brown (10YR 3/2) when moist; common, medium, distinct mottles of strong brown (7.5YR 5/6); moderate, fine and medium, angular blocky structure; firm when moist, sticky and plastic when wet; noncalcareous; gradual, wavy boundary.
- **IIICg1**—19 to 33 inches, dark-gray (10YR 4/1) clay, very dark grayish brown (10YR 3/2) when moist; few, fine, faint, strong-brown (7.5YR 5/6) mottles; massive; very firm when moist, very sticky and very plastic when wet; noncalcareous; clear, smooth boundary.
- **IVCg2**—33 to 36 inches, dark-gray (10YR 4/1) sandy clay loam, very dark grayish brown (10YR 3/2) and dark yellowish brown (10YR 4/4) when moist; massive; friable when moist, sticky and slightly plastic when wet; noncalcareous; clear, smooth boundary.
- **VCg3**—36 to 52 inches, light greenish-gray (5BG 7/1) and light yellowish-brown (2.5Y 6/4) clay, greenish gray (5BG 5/1) and light olive brown (2.5Y 5/4) when moist; massive; very firm when moist, very sticky and very plastic when wet; noncalcareous; tongues of soil material from the IVCg2 horizon extend downward into this horizon.

The A1 horizon ranges from 3 to 8 inches in thickness and from silty clay loam to silty clay or clay in texture. In places the IIB1g horizon has strong instead of moderate structure, and the structure is weak, coarse, prismatic in a few places. The IIB1g horizon ranges from 14 to 24 inches in thickness. In pastures that have been lightly grazed or in idle fields, partly decayed organic matter has accumulated at the surface. In some places these soils are noncalcareous to a depth of more than 60 inches, but generally lime occurs in the profile somewhere between a depth of 30 and 60 inches.

Duncom Series

The Duncom series consists of dark-colored, well-drained silt loams and loams of the Lithosol great soil group that are shallow over limestone bedrock. These soils developed in friable material weathered from bedrock. They are in the southeastern one-fourth of the county, at the summit of a few buttes that are capped by limestone of the White River formation. The slopes are between 1 and 5 percent.

The underlying limestone is the main characteristic that separates these soils from the Flasher, Bainville, and Midway series, which are shallow over sandstone and soft shale. The Duncom soils have a thinner A1 horizon and lack the B2 horizon that is typical in the profile of the Little Horn soils.

Typical profile of Duncom silt loam, 1,431 feet south and 732 feet west of the northeast corner of section 22, T. 131, N., R. 91 W.:

- **A1**—0 to 4 inches, black (10YR 2/1, moist) silt loam; fine, weak, crumb structure; soft when dry, very friable when moist, nonsticky when wet; noncalcareous; clear, wavy boundary.
- **AC**—4 to 11 inches, dark-gray (10YR 4/1, moist) silt loam; medium, weak, prismatic structure; very friable when moist, slightly sticky when wet; strongly calcareous; abrupt, irregular boundary.
- **IIR1**—11 to 26 inches, light-gray (10YR 7/1, moist), hard, platy limestone; strongly calcareous; abrupt, irregular boundary.
- **IIIC1**—26 to 46 inches, light olive-gray (5Y 6/2, moist) silty clay; very firm when moist, sticky and plastic when wet; calcareous; abrupt, irregular boundary.
- **IVR2**—46 to 50 inches, bedded limestone that is hard and fractured.

In places the A1 horizon is very dark brown instead of black. The texture of the A1 horizon ranges from silt loam to clay loam, and the thickness of that horizon ranges from 3 to 6 inches. In places the A1 horizon is calcareous. The B2 horizon is absent, but there is a transitional, partly weathered AC horizon, 2 to 9 inches thick, in some places. In many places the substratum contains thin layers of limestone, or a lithologic discontinuity, that is of different hardness than the underlying bedrock.

Farland Series

The Farland series consists of deep, dark-colored soils that are well drained and are in the Chestnut great soil group. These soils developed in loamy alluvium on stream terraces. They have strong structure and well-defined horizons. In most places their slopes are less than 3 percent, but they are as steep as 8 percent along the edges of the terraces.

The Farland soils developed in stratified alluvium instead of in material weathered from soft shale like the Morton soils. They have a thinner and lighter colored A horizon than the Arnegard soils. The Farland soils have finer textured, thicker B horizons and lack the thick gravelly substratum that is typical of the Manning soils. They have a thinner A1 horizon and contain more clay and silt than the Parshall soils, and they also have a prominent Cca horizon that is lacking in the Parshall soils.

Typical profile of Farland silt loam, 1,350 feet west and 220 feet north of the S¼ corner of section 28, T. 141 N., R. 93 W. (Sample No. S-58-NE-45-20, Laboratory No. 8600-08: See the section "Physical and Chemical Properties of Soils"):

- **A1**—0 to 3 inches, very dark grayish-brown (10YR 3/2) silt loam, black (10YR 2/1) when moist; weak, thin, platy structure but breaks to moderate, fine, crumb structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; abrupt, smooth boundary.
- **B21**—3 to 7 inches, dark-gray (10YR 4/1) silt loam, very dark brown (10YR 2/1) when moist; moderate, medium, prismatic structure but breaks to moderate angular blocky structure; all the surfaces of the prisms coated with black (10YR 2/1) clay; hard when dry, friable when moist, slightly sticky and plastic when wet; noncalcareous; gradual, smooth boundary.
- **B22**—7 to 15 inches, dark grayish-brown (2.5Y 4/2) silty clay loam, very dark gray (10YR 3/1) when moist; moderate, medium, prismatic structure but breaks to moderate, medium, angular blocky structure; has very dark brown (10YR 2/2) clay skins on all the surfaces of the prisms; hard when dry, friable when moist, sticky and plastic when wet; noncalcareous; gradual, smooth boundary.
- **B23**—15 to 25 inches, olive-gray (5Y 4/2) silty clay loam, very dark grayish brown (2.5Y 3/2) when moist; strong, medium, prismatic to strong, medium, blocky structure; very dark gray (2.5Y 3/1) clay skins on the vertical surfaces of the peds; hard when dry, firm

when moist, sticky and plastic when wet; noncalcareous; clear, smooth boundary.

C1ca—25 to 31 inches, olive-gray (5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; weak, coarse, prismatic structure but breaks to strong, coarse and medium, angular blocky structure; patches of clay skins on the vertical surfaces of the prisms; hard when dry, firm when moist, sticky and plastic when wet; very strongly calcareous and contains common, fine, distinct, white (2.5Y 8/2) lime threads; gradual, smooth boundary.

C2ca—31 to 39 inches, olive-gray (5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; strong, coarse, angular blocky structure; hard when dry, firm when moist, sticky and plastic when wet; very strongly calcareous and contains common, fine, distinct, white (2.5Y 8/2) threads and nodules of lime; gradual, smooth boundary.

C3ca—39 to 47 inches, (horizon split for laboratory sampling) identical to C2ca horizon, except for very hard consistence when dry.

C4—47 to 54 inches, olive (5Y 5/3) silty clay loam, olive brown (2.5Y 4/3) when moist; strong, coarse and medium angular blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; strongly calcareous and contains common, fine, distinct lime threads; clear, wavy boundary.

C5—54 to 60 inches, olive-gray (5Y 5/2) silt loam, olive brown (2.5Y 4/3) when moist; strong, medium, blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; strongly calcareous.

The thickness of the A1 horizon ranges from 3 to 6 inches, and the texture of that horizon is loam instead of silt loam in some places. The B horizons range from loam to silty clay loam or clay loam in texture, and their combined thickness ranges from 18 to 32 inches. The texture of the substratum ranges from sandy loam to silty clay loam. In many places the lower part of the profile contains all or parts of A horizons that have been buried by subsequent deposition. Depth to the Cca horizon ranges from 20 to 30 inches.

Flasher Series

In the Flasher series are soils of the uplands that are in the Regosol great soil group. These soils developed in material weathered from soft sandstone of Tertiary age. They are rolling to steep and are excessively drained. Flasher soils are extensive in Stark County, and they are widely distributed.

The Flasher soils lack the well-developed profile and the distinct B2 horizon that are typical of the Vebar soils, and their solum is thinner than that of the Lihen soils. In contrast to the Bainville and Chama soils, developed in material weathered from soft silty shale, they developed in material weathered from sandstone. The catenary sequence for these soils in Stark County generally is Flasher, Vebar, Parshall, and Arnegard.

Typical profile of Flasher sandy loam, 30 rods north and 12 rods east of the southwest corner of the northwest quarter of section 11, T. 139 N., R. 91 W.:

A1—0 to 8 inches, dark grayish-brown (2.5Y 4/2) sandy loam, very dark grayish brown (2.5Y 3/2) when moist; weak, fine, subangular blocky structure and single grain; soft when dry, very friable when moist, nonsticky and nonplastic when wet; slightly calcareous; abrupt, wavy boundary.

C1—8 to 14 inches, brown (7.5YR 5/4) loamy sand, dark brown (7.5YR 4/4) when moist; fractured soft sandstone that can be crushed in the hand to loamy sand; nonsticky and nonplastic when wet; strongly calcareous; abrupt, wavy boundary.

C2—14 to 20 inches, yellowish-brown (10YR 5/4) loamy sand, dark yellowish brown (10YR 4/4) when moist; massive; slightly hard when dry, firm when moist, nonsticky and nonplastic when wet; strongly calcareous; clear, wavy boundary.

C3—20 to 50 inches, light olive-gray (5Y 6/2) loamy sand, olive gray (5Y 4/2) when moist; massive; soft when dry, very friable when moist, nonsticky and nonplastic when wet; noncalcareous.

The texture of the A1 horizon ranges from fine sandy loam to loamy fine sand, and the thickness of that horizon ranges from 2 to 9 inches. Although the typical Flasher soils do not contain a B horizon, in a few places they have a weak, thin B horizon that has the same textural range as the A. Where the B horizon occurs, its thickness ranges from 3 to 10 inches. The content of lime varies considerably from one profile to another. The content depends upon the amount of lime in the stratified underlying rock. This rock is calcareous in some places, but an abrupt boundary separates the calcareous layer of rock from a noncalcareous layer in some places. The total thickness of the solum ranges from 2 to 25 inches. The sandstone in the underlying material ranges from weakly cemented to indurated.

Gallatin Series

The soils of the Gallatin series are in the Alluvial great soil group and are on the present flood plains of the major streams. They are imperfectly drained and are nearly level. Gleyed soil colors and distinct brown and yellow mottles are common below a depth of 20 inches. The slopes range from 0 to 2 percent. In most places the lower part of the profile is calcareous.

The Gallatin soils occur with the Havre and Straw soils, but they generally have a darker, thicker A horizon than those soils and are less well drained. They contain less clay than the Dimmick soils and are better drained than those soils. They do not contain the prominent Cca horizon that is typical in the profile of the Colvin soils, and they lack the high water table that is typical of those soils.

Typical profile of Gallatin clay loam along the Green River, 132 feet south and 18 rods east of the northwest corner of section 1, T. 139 N., R. 95 W.:

A11—0 to 7 inches, dark-gray (10YR 4/1) clay loam, black (10YR 2/1) when moist; moderate, medium, angular blocky to moderate, coarse, crumb structure; slightly hard when dry, friable when moist; slightly sticky and slightly plastic when wet; noncalcareous; clear, smooth boundary.

A12—7 to 14 inches, very dark grayish-brown (2.5Y 3/2) silt loam, black (10YR 2/1) when moist; weak, coarse, prismatic to moderate, fine and medium, angular blocky structure; soft when dry, friable when moist, nonsticky and slightly plastic when wet; noncalcareous; clear, smooth boundary.

C1—14 to 27 inches, grayish-brown (2.5Y 5/2) loam, dark grayish brown (2.5Y 4/2) when moist; has mottles of dark yellowish brown (10YR 4/4 and 10YR 3/4); moderate, coarse, angular blocky to moderate, thick and medium, platy structure; soft when dry, friable when moist, nonsticky and slightly plastic when wet; slightly calcareous; abrupt, smooth boundary.

C2—27 to 38 inches, grayish-brown (2.5Y 5/2) loam, dark grayish brown (2.5Y 4/2) when moist; has mottles of dark yellowish brown (10YR 3/4 and 10YR 4/4); moderate thick and medium platy structure; soft when dry, friable when moist, nonsticky and slightly plastic when wet; calcareous; clear, smooth boundary.

C3—38 to 42 inches, (auger sample); gray (5Y 5/1) loam, dark gray (5Y 4/1) when moist; soft when dry, friable when moist; calcareous; clear, smooth boundary.

C4—42 to 58 inches, (auger sample); gray (5Y 5/1) and dark grayish-brown (2.5Y 4/2) silty clay loam, dark gray (5Y 4/1) and very dark grayish brown (2.5Y 3/2) when moist; hard when dry, friable when moist, sticky and slightly plastic when wet; calcareous.

The A horizon ranges from 7 to 18 inches in thickness, and the texture of that horizon ranges from loam to clay loam or silty clay loam. The combined thickness of the C1 and C2 horizons ranges from 16 to 26 inches, and in general, the structure of those horizons ranges from weak prismatic to blocky. The underlying horizons are stratified alluvium, and their texture changes abruptly from sandy loam to silty clay loam. In a few places noncalcareous layers of sandy loam occur in the underlying material.

Glendive Series

In the Glendive series are soils of the Alluvial great soil group that developed on moderately sandy bottom lands and flood plains. These soils are along the major streams of the county. They are mainly nearly level but are gently undulating in some places. The slopes range from 0 to 2 percent.

The Glendive soils occur with the Banks and Havre soils, but unlike those soils, they have a surface layer of fine sandy loam. The Glendive soils lack the thick, dark A horizon and the moderately distinct B horizon that are typical of the Parshall soils. They are more sandy than the Straw soils, and they lack the B2 horizon that is typical in the profile of the Straw soils.

Typical profile of Glendive fine sandy loam in native grass, 316 feet east and 1,185 feet north of the southwest corner of section 9, T. 139 N., R. 95 W.:

A1—0 to 5 inches, dark grayish-brown (2.5Y 4/2) fine sandy loam, very dark grayish brown (2.5Y 3/2) when moist; weak, fine, angular blocky structure or single grain; soft when dry, very friable when moist, nonsticky and nonplastic when wet; noncalcareous; clear, smooth boundary.

C1—5 to 11 inches, grayish-brown (2.5Y 5/2) loamy fine sand, very dark grayish brown (2.5Y 3/2) when moist; weak, coarse, prismatic to moderate, angular blocky structure; soft when dry, loose when moist, nonsticky and nonplastic when wet; slightly calcareous; gradual, wavy boundary.

C2—11 to 16 inches, grayish-brown (2.5Y 5/2) loamy fine sand, dark grayish brown (2.5Y 4/2) when moist; single grain; loose both when dry and moist, nonsticky and nonplastic when wet; noncalcareous; clear, wavy boundary.

C3—16 to 21 inches, grayish-brown (2.5Y 5/2) fine sandy loam, dark grayish brown (2.5Y 4/2) when moist; moderate, fine and coarse, angular blocky structure; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; calcareous; clear, wavy boundary.

C4—21 to 26 inches, grayish-brown (2.5Y 5/2) fine sandy loam, dark grayish brown (2.5Y 4/2) when moist; weak, medium and coarse, angular blocky structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; calcareous; clear, wavy boundary.

C5—26 to 35 inches, (auger sample); grayish-brown (2.5Y 5/2) very fine sandy loam, dark grayish brown (2.5Y 4/2) when moist; soft when dry, very friable when moist, nonsticky and nonplastic when wet; calcareous; clear, wavy boundary.

C6—35 to 51 inches, (auger sample); light brownish-gray (2.5Y 6/2) loamy fine sand, dark grayish brown (2.5Y 4.2) when moist; soft when dry, loose when moist, nonsticky and nonplastic when wet; slightly calcareous.

The A horizon ranges from 4 to 12 inches in thickness, and its texture is sandy loam in some places. The texture of the stratified material below the A horizon ranges from loam to loamy fine sand. In a few places the color of the underlying material is as dark as that of the surface layer. The structure ranges from weak prismatic or blocky in the upper part of the profile to predominantly single grain or massive in the lower part. The soil material ranges from noncalcareous to strongly calcareous, although these soils do not contain a horizon designated as *ca*.

Grail Series

In the Grail series are deep, well-drained soils of the Chestnut great soil group. These soils developed in moderately fine textured colluvial sediments in the uplands. They occur in concave drainageways and on foot slopes throughout the county. In most places the Grail soils are nearly level, but the slopes are as steep as 8 percent in somes places.

The Grail soils occur with the Morton, Regent, and Farland soils, but they generally have a thicker and darker colored solum than those soils and have lime at a greater depth. They also occur in the same general areas as the Arnegard soils, but they have more clay in the B and C horizons and have stronger structure.

A typical profile of Grail silty clay loam in a cultivated field, 150 feet east of State Highway No. 22 and 1,320 feet south of the Dunn County line in section 3, T. 140 N., R. 96 W.:

A1p—0 to 5 inches, dark grayish-brown (2.5Y 4/2) silty clay loam, black (10YR 2/1) when moist; medium crumb structure; slightly hard when dry, friable when moist, slightly sticky when wet; noncalcareous; abrupt, smooth boundary.

A1—5 to 10 inches, very dark grayish-brown (2.5Y 3/2) silty clay loam, very dark brown (10YR 2/2) when moist; medium crumb structure to weak, fine, angular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; noncalcareous; abrupt boundary; tongues from the A1 horizon extend downward 4 to 6 inches into the B2t horizon.

B2t—10 to 32 inches, dark grayish-brown (2.5Y 4/2) silty clay, very dark grayish brown (2.5Y 3/2) when moist; moderate, medium, prismatic and strong, medium, angular blocky structure; hard when dry, very firm when moist, sticky and plastic when wet; clay films coat all the surfaces of the peds; noncalcareous; clear, wavy boundary.

Cca—32 to 42 inches, (auger sample); grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; hard when dry, firm when moist, very sticky and very plastic when wet; strongly calcareous and contains many fine white films and nodules of segregated lime; gradual, wavy boundary.

C1—42 to 60 inches, (auger sample); grayish-brown (2.5Y 5/2) clay loam, very dark grayish brown (2.5Y 3/2) when moist; hard when dry, friable when moist, sticky when wet; calcareous.

The combined A horizons range from 8 to 14 inches in thickness and from silt loam to silty clay loam in texture. In some places the profile contains a B1 or B3 horizon, but those horizons are absent in other profiles. Where present, these horizons have a texture that ranges from clay loam or silty clay loam to silty clay, and they range from 15 to 33 inches in total thickness. The clay films on the surfaces of the peds in the B2t horizon range from thin to thick. In places, beneath the B horizon, the profile contains thin, buried A horizons. In some areas

the substratum contains nests of gypsum crystals. These range from a few visible nests to many prominent ones.

Havre Series

The Havre series consists of soils of the Alluvial great soil group that developed in medium and moderately fine textured alluvium. These soils are moderately well drained and occur on the lower benches of the bottom lands along the Heart and Green Rivers. The slopes range from 0 to 4 percent, but they are less than 1 percent in most places. The Havre soils show little profile development. Buried dark-colored horizons are common at any depth in most profiles.

The Havre soils are finer textured than the Glendive and Banks soils, and they lack a B2 horizon and generally have weaker structure than typical for the Farland and Straw soils. The Havre soils are finer textured than the Parshall soils. Also, they are slightly calcareous and lack a B horizon.

Typical profile of Havre loam, 43 rods east of the north abutment of a bridge on a county road over Antelope Creek, in the southwest quarter of section 5, T. 138 N., R. 95 W.:

A1p—0 to 10 inches, grayish-brown (2.5Y 5/2) loam, very dark grayish brown (2.5Y 3/2) when moist; weak, medium and fine, angular blocky structure to single grain; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; slightly calcareous; clear, wavy boundary.

A1b—10 to 14 inches, dark grayish-brown (2.5Y 4/2) silt loam, very dark grayish brown (2.5Y 3/2) when moist; moderate, coarse, angular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; slightly calcareous; few faint nodules of lime; abrupt irregular boundary.

C1—14 to 16 inches, grayish-brown (2.5Y 5/2) loam, very dark grayish brown (2.5Y 3/2) when moist; moderate, coarse, angular blocky structure; slightly hard when dry, friable when moist; slightly sticky and slightly plastic when wet; very slightly calcareous; clear, wavy boundary.

C2—16 to 44 inches, grayish-brown (2.5Y 5/2) loam, very dark grayish brown (2.5Y 3/2) when moist; weak, coarse, prismatic and moderate, coarse, angular blocky structure; soft when dry, friable when moist, nonsticky and nonplastic when wet; slightly calcareous; few faint nodules of lime; has a discontinuous layer of dark-colored material near the top of the horizon.

IIC3—44 to 50 inches, grayish-brown (2.5Y 5/2) stratified sands and silts that contain pebbles and are very dark grayish brown (2.5Y 3/2) when moist; soft when dry, very friable when moist, nonsticky and nonplastic when wet; very slightly calcareous; a few pockets of segregated lime.

The surface layer ranges from loam to silty clay loam in texture and from 4 to 12 inches in thickness. The texture of the stratified alluvium in the substratum ranges from fine sandy loam to loam or clay loam in texture, and this material ranges from noncalcareous to strongly calcareous.

Hoven Series

In the Hoven series are somewhat poorly drained, nearly level solodized-Solonetz soils that are nearly level. These soils occur in clay-filled basins in the uplands.

The Hoven soils occur with well-drained Regent and Morton soils of the Chestnut great soil group. They lack the dark-colored A1 horizon that has granular structure and the strongly mottled B and C horizons that are typical of the Dimmick soils. The Hoven soils have poorer drainage and have thicker B2 horizons than the Rhoades soils. Unlike the Gallatin soils, which are friable and formed in alluvium, they have solonetzic characteristics. Also, they have a higher content of clay than the Gallatin soils.

Typical profile of Hoven silty clay loam, 115 feet north and 0.42 mile west of the southeast corner of section 35, T. 140 N., R. 99 W.:

A2—0 to 1½ inches, gray (N 5/0) silty clay loam, black (10YR 2/1) when moist; moderate, medium, subangular blocky and weak platy structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; abrupt, smooth boundary.

B21—1½ to 16 inches, gray (5Y 5/1) clay, dark gray (5Y 4/1) when moist; moderate, coarse, prismatic and strong, fine and medium, angular blocky structure; very hard when dry, very firm when moist, very sticky and very plastic when wet; noncalcareous; gradual, smooth boundary.

B22—16 to 30 inches, gray (5Y 5/1) clay, dark gray (5Y 4/1) when moist; weak, coarse, prismatic and moderate, medium, angular blocky structure; very hard when dry, very firm when moist, very sticky and very plastic when wet; calcareous; gradual, smooth boundary.

C1—30 to 40 inches, olive-gray (5Y 5/2) clay, olive gray (5Y 4/2) when moist; massive; extremely hard when dry, very firm when moist, very sticky and very plastic when wet; strongly calcareous; gradual, smooth boundary.

Ccs—40 to 49 inches, (auger sample); gray (5Y 5/1) clay, dark gray (5Y 4/1) when moist; extremely hard when dry, very firm when moist, very sticky and very plastic when wet; slightly calcareous.

C2—49 to 58 inches, (auger sample); gray (5Y 5/1) clay, olive gray (5Y 5/2) when moist; extremely hard when dry, very firm when moist, very sticky and very plastic when wet; noncalcareous.

In only a few places do these soils have an A1 horizon. Where an A1 horizon is present, it is less than 1 inch thick. The A2 horizon ranges from ½ inch to 3 inches in thickness and from loam to clay loam or silty clay loam in texture. In places the structure of the B2 horizons is medium or coarse columnar or is medium prismatic. The combined B2 horizons range from 24 to 32 inches in thickness. In places the B22 horizon is noncalcareous. Some profiles have mottling below the B2 horizons.

Lefor Series

The Lefor series consists of soils that developed in moderately sandy material weathered from the Golden Valley formation. These soils are in the Chestnut great soil group. They are well drained. The slopes range from 2 to 10 percent but are between 3 and 6 percent in most places. These soils are extensive in the central part of Stark County.

The Lefor soils have a thinner A1 horizon and have more clay in the B2 horizons than the Vebar and Parshall soils. They have a finer textured solum and substratum than the Lihen soils. The texture of fine sandy loam and sandy clay loam in the profile distinguish the Lefor from the Morton soils.

Typical profile of Lefor sandy loam, 300 feet east and 85 feet north of the W¼ corner of section 13, T. 137 N., R. 95 W. (Sample No. S–58–ND–45–21, Laboratory No. 8609–16: See the section "Physical and Chemical Properties of Soils"):

Ap—0 to 6 inches, grayish-brown (2.5Y 5/2) sandy loam, very dark brown (10YR 2/2) when moist; moderate, medium, crumb structure; slightly hard when dry, friable

when moist, slightly sticky and slightly plastic when wet; noncalcareous; clear, smooth boundary.

B1—6 to 15 inches, grayish-brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) when moist; strong, very coarse, prismatic structure but breaks to weak, fine, crumb structure; the surfaces of the prisms covered by a coating of organic matter one-eighth of an inch thick; hard when dry, friable when moist, slightly sticky and plastic when wet; noncalcareous; smooth, gradual boundary.

B2—15 to 24 inches, light brownish-gray (2.5Y 6/2) sandy clay loam, dark grayish brown (10YR 4/2) when moist; strong, very coarse, prismatic and moderate, medium, angular blocky structure; all the surfaces of the prisms, the tops and vertical surfaces of the blocks, and many individual grains of sand coated with very dark grayish-brown (10YR 3/2) clay; hard when dry, friable when moist, sticky and plastic when wet; noncalcareous.

Bca—24 to 36 inches, pale-yellow (2.5Y 8/3) sandy clay, light brownish gray (2.5Y 6/2) when moist; strong, very coarse, prismatic structure but breaks to moderate, medium, angular blocky structure; all the surfaces of the prisms and the vertical surfaces of the blocks coated with clay that is grayish brown (2.5Y 5/2) when moist; hard when dry, friable when moist, sticky and plastic when wet; very strongly calcareous and contains a few nodules of lime; clear, smooth boundary.

C1—36 to 47 inches, pale-yellow (5Y 8/4) sandy clay loam, light yellowish brown (2.5Y 6/4) when moist; weak, medium, platy and weak, medium, angular blocky structure; the surfaces of the peds have broken clay coatings that are light olive brown (2.5Y 5/4) when moist; slightly hard when dry, friable when moist, sticky and plastic when wet; calcareous.

Ccs—47 to 53 inches, pale-yellow (2.5Y 8/4) sandy clay loam, pale yellow (2.5Y 7/4) when moist; weak, fine, angular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; calcareous; contains many pockets of fine, faint, light-gray (2.5Y 7/2) gypsum.

C2—53 to 58 inches, pale-yellow (5Y 8/4) sandy clay loam, light yellowish brown (10YR 6/4) when moist; moderate, medium, platy and weak, fine, angular blocky structure; slightly hard when dry, friable when moist, sticky and plastic when wet; calcareous.

C3—58 to 63 inches, pale-yellow (5Y 8/4) sandy clay loam, light brownish gray (2.5Y 6/2) when moist; moderate, medium, platy structure; slightly hard when dry, friable when moist, sticky and plastic when wet; weakly calcareous.

The A horizon ranges from 0 to 7 inches in thickness because erosion has been variable. In Stark County the texture of the A horizon of these soils is generally fine sandy loam. The texture of the B horizons ranges from sandy clay loam or sandy clay to fine sandy loam. The films on the prisms are continuous and range from thin to thick. In some places the profile lacks the weak zone of calcium carbonate. The underlying material consists of beds of stratified sandy material in which there are varying amounts of kaolinite mixed with sand.

Lihen Series

In the Lihen series are excessively drained soils developed in sandy material that has been reworked by wind. These soils are in the Chestnut great soil group. They have minimal characteristics for inclusion in that group, however, and are integrading toward the Regosol great soil group. These soils occur in scattered areas throughout the eastern two-thirds of Stark County. The slopes range from 1 to 15 percent, but they are between 4 and 10 percent in most places.

In many cultivated fields, the A1p horizon of these soils is light colored because much of the organic matter has been lost as the result of cultivation and recent wind erosion. In cultivated areas the soil material in the plow layer has been sorted and resorted by wind.

The Lihen soils have a thicker solum than the Flasher soils. They are coarser textured, are lighter colored, and have weaker structure than the Vebar and Parshall soils. Their noncalcareous solum and their weak color B horizons distinguish them from the Glendive and Banks soils.

Profile of Lihen loamy fine sand, 0.10 mile north and 50 feet east of the southwest corner of the southeast quarter of section 20, T. 139 N., R. 94 W.:

A1p—0 to 12 inches, grayish-brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) when moist; single grain; loose both when dry and moist, nonsticky and nonplastic when wet; noncalcareous; clear, smooth boundary.

A1b—12 to 18 inches, dark grayish-brown (10YR 4/2) loamy sand, very dark gray (10YR 3/1) when moist; single grain; loose both when dry and moist, nonsticky and nonplastic when wet; noncalcareous; clear, smooth boundary.

B2b—18 to 25 inches, grayish-brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic and weak, coarse, angular blocky structure; loose when dry, very friable when moist, nonsticky and nonplastic when wet; noncalcareous; clear, wavy boundary.

IIBb—25 to 34 inches, dark-brown (10YR 4/3) loam, moist; weak, coarse, prismatic and weak, coarse angular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; gradual, wavy boundary.

IIIC—34 to 40 inches, pale-brown (10YR 6/3) sandy loam, brown (10YR 5/3) when moist; massive; loose when dry and moist, nonsticky and nonplastic when wet; noncalcareous; clear, smooth boundary.

IVC—40 to 60 inches, pale-brown (10YR 6/3, moist) loamy fine sand; single grain; loose both when dry and moist, nonsticky and nonplastic when wet; noncalcareous.

The thickness of the combined A horizons ranges from 2 to 18 inches. The color of the surface layer in areas under range vegetation is one value darker in most places than that in the profile described. The texture of the B horizons ranges from sand to loamy fine sand. In places some parts of the B horizon are darker than the A1 horizon. The buried horizon is absent in some profiles. In a few areas the substratum contains thin horizons of gravelly material. The substratum ranges from 20 to 35 inches in thickness. In a few places the substratum contains a calcareous horizon.

Little Horn Series

The Little Horn series consists of moderately deep, well-drained soils that developed in silty material over thick beds of limestone. These are Chestnut soils but are intergrading toward the Chernozem great soil group. They occur at the highest elevation in Stark County and developed in the youngest of the sediments weathered from bedrock. These sediments are part of the White River formation. The uppermost 3 to 6 inches of the substratum contains fragments of slightly weathered limestone. In most areas this material grades, within a short distance, to consolidated bedrock. The slopes range from 1 to 5 percent.

The limestone substratum distinguishes the Little Horn soils from the other moderately deep and deep soils of Stark County. The Little Horn soils occur with the Duncom soils, but unlike the Duncom soils, they have a distinct B horizon and are moderately deep over limestone.

Typical profile of Little Horn silt loam, 96 rods south and 39 rods west of the northeast corner of section 22, T. 139 N., R. 91 W.:

A1—0 to 8 inches, very dark gray (10YR 3/1) silt loam, black (10YR 2/1) when moist; moderate, medium, prismatic and strong, fine and medium, subangular blocky structure; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; noncalcareous; clear, wavy boundary.

B21t—8 to 15 inches, dark-gray (10YR 4/1) weak silty clay loam, very dark gray (10YR 3/1) when moist; strong, medium, prismatic and strong, fine and medium, subangular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous; patches of clay films are on the horizontal surface of the peds, and thin continuous coatings are on the vertical surfaces; gradual, wavy boundary.

B22—15 to 27 inches, light brownish-gray (2.5Y 6/2) weak silty clay loam, dark grayish brown (2.5Y 4/2) when moist; moderate, coarse, prismatic and strong, fine and medium, angular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous; abrupt, smooth boundary.

IIR—27 to 30 inches, light-gray (2.5Y 7/2) limestone, light brownish gray (2.5Y 6/2) when moist; massive and is fractured in places; extremely hard, strongly calcareous. (Pieces of the limestone completely dissolve if hydrochloric acid is added.)

In places the A1 horizon is black. The texture of the A1 horizon is loam instead of silt loam in some places. The thickness of the A1 horizon ranges from 4 to 9 inches. The texture of the B2 horizons ranges from loam to silty clay loam, and the combined thickness of those horizons ranges from 10 to 25 inches.

Manning Series

In the Manning series are well-drained soils of the Chestnut great soil group. These soils developed in alluvium of loam or fine sandy loam that is underlain by gravelly and sandy alluvium. Their slopes range from 0 to 10 percent, but they are mainly between 1 and 3 percent.

The Manning soils have stronger structure throughout the profile and more silt and clay in the B2 horizon than the Parshall, Vebar, and Lihen soils. Also, unlike those soils, they have a thick, gravelly substratum. They are coarser textured than the Farland soils, which also lack the thick gravelly substratum.

Typical profile of Manning fine sandy loam, 200 feet west and 1,510 feet south of the E¼ corner of section 11, T. 139 N., R. 97 W. (Sample No. S-58-ND-45-5, Laboratory No. 8504-10: See the section "Physical and Chemical Properties of Soils"):

A1—0 to 3 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark brown (10YR 2/2) when moist; moderate, medium, crumb structure but breaks to single grain; slightly hard when dry, very friable when moist, slightly sticky and nonplastic when wet; noncalcareous; clear, smooth boundary.

B2—3 to 13 inches, grayish-brown (2.5Y 5/2) loam, very dark grayish brown (2.5Y 3/2) when moist; strong, medium, prismatic structure but breaks to moderate, medium, angular blocky structure; the tops and vertical surfaces of the peds are coated with clay skins that are very dark brown (10YR 2/2) when moist; hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; noncalcareous.

Cca—13 to 19 inches, grayish-brown (2.5Y 5/2) loam, olive brown (2.5Y 4/3) when moist; weak, medium, prismatic structure but breaks to moderate, medium, angular blocky structure; hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; very strongly calcareous and contains many prominent nodules of white (2.5Y 8/2) lime; abrupt, smooth boundary.

IIC1—19 to 28 inches, grayish-brown (2.5Y 5/2) gravely coarse loamy sand, very dark grayish brown (2.5Y 3/2) when moist; single grain; nonsticky and nonplastic when wet; calcareous; 60 to 70 percent, by volume, is gravel; gradual, wavy boundary.

IIC2—28 to 41 inches, dark grayish-brown (2.5Y 4/2) gravelly coarse loamy sand, very dark grayish brown (2.5Y 3/2) when moist; single grain; slightly sticky and nonplastic when wet; strongly calcareous; 60 to 70 percent, by volume, is gravel; abrupt, smooth boundary.

IIIC3—41 to 47 inches, light-gray (2.5Y 7/2) loam, olive brown 2.5Y 4/4) when moist; weak, coarse and medium, subangular blocky structure; very hard when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous and contains common, medium, prominent, white (10YR 8/2) nodules of lime; this horizon is strongly crossbedded with strata of sandy loam, loam, and silt loam; common, medium, prominent, yellowish-brown (10YR 5/6) iron stains present; abrupt, wavy boundary.

IVC4—47 to 60 inches, grayish-brown (2.5Y 5/2) sand, dark grayish brown (2.5Y 4/2) when moist; loose when dry, very friable when moist, nonsticky and nonplastic when wet; noncalcareous.

The A1 horizon ranges from 3 to 7 inches in thickness, and the texture of that horizon is loam in some places. The texture of the B2 horizon ranges from loam to light clay loam, and the thickness of that horizon ranges from 10 to 30 inches. The texture of the substratum ranges from gravelly loam or gravelly coarse sandy loam to loamy sand, and the thickness of the substratum ranges from 16 inches to several feet.

Midway Series

The soils of the Midway series are excessively drained Lithosols that are shallow over shale. They developed in material weathered from calcareous, moderately fine textured and fine textured, soft shale of the Fort Union, Golden Valley, and White River formations. These soils are gently sloping to steep. Their slopes range from 5 to 35 percent.

The Midway soils occur with the Bainville, Chama, and Moreau soils. They have a finer textured A1 horizon than the Bainville soils, and they are underlain by beds of silty clay loam, clay loam, and silty clay shale instead of by medium-textured material. Unlike the Chama soils, the Midway soils have a moderately fine textured surface layer and no B horizon. Also, they contain less lime than the Chama soils, and unlike those soils, they have a substratum of stratified clayey shale. The Midway soils are the catenary associates of the Regent and Moreau soils, but they are shallower than those soils, and they lack a B horizon.

Profile of Midway clay loam, 170 rods west and 71 rods north of the southeast corner of section 9, T. 139 N., R. 95 W.:

A1—0 to 5 inches, olive (5Y 5/3) clay loam, olive (5Y 4/3) when moist; weak, coarse and medium, subangular

blocky and weak, fine, crumb structure; slightly hard when dry, friable when moist, sticky and plastic when wet; calcareous; clear, wavy boundary.

IIC—5 to 13 inches, light-gray (5Y 7/1) silty clay loam shale, dark gray (5Y 4/1) when moist; moderate, medium, platy structure; hard when dry, firm when moist, sticky and plastic when wet; calcareous; gradual, wavy boundary.

IIIC1—13 to 18 inches, light-gray (5Y 7/1) silty clay shale, gray (5Y 5/1) when moist; thick platy and bedded; hard when dry, firm when moist; weakly calcareous; gradual, wavy boundary.

IIIC2—18 to 42 inches, light-gray (5Y 7/1) and light yellowish-brown (10YR 6/4) silty clay shale, gray (5Y 5/1) and olive (5Y 5/4) when moist; thick platy and bedded; very hard when dry, firm when moist; noncalcareous.

The A1 horizon ranges from 2 to 6 inches in thickness and from clay loam to silty clay loam or silty clay in texture. The texture of the substratum ranges from clay loam or silty clay loam to clay, and this material ranges from noncalcareous to strongly calcareous. In many places gypsum is concentrated in the cracks and between the plates of the bedded shale.

Moreau Series

The soils of the Moreau series are in the Chestnut great soil group, but they have minimal characteristics for inclusion in that group. They developed in dense, alkaline, clayey shale of the Fort Union, Golden Valley, and White River formations. These soils are extensive on the uplands of Stark County. They have good surface drainage but slow internal drainage. Their slopes are mainly gentle, but they range from 2 to 12 percent.

The Moreau soils have a lighter colored, thinner solum and contain less clay than the Promise soils. They have a thinner solum and are calcareous nearer the surface than the Regent soils. The Moreau soils are more grayish, have a thinner solum, and contain more clay than the Morton soils. They occur with the Bainville and Midway soils, but they have a B2 horizon that is lacking in those soils.

Typical profile of Moreau silty clay, 0.05 mile south and 0.05 mile west of the northeast corner of section 15, T. 137 N., R. 96 W.:

Ap—0 to 5 inches, gray to light-gray (2.5Y 6/1) silty clay, dark grayish brown (2.5Y 4/2) when moist; fine and medium subangular blocky structure and moderate, fine, granular structure; friable when moist, very sticky and very plastic when wet; slightly calcareous; abrupt, smooth boundary.

B2—5 to 12 inches, grayish-brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) when moist; weak, medium and coarse, prismatic and strong, fine, angular blocky structure; clay films that are dark grayish brown (2.5Y 3/2) when moist are on the surfaces of the peds; firm when moist, sticky and plastic when wet; slightly calcareous; clear, wavy boundary.

B3—12 to 17 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; weak, coarse, prismatic and strong, fine, angular blocky structure; the peds are coated with clay films that are very dark grayish brown (2.5Y 3/2) when moist; firm when moist, sticky and plastic when wet; slightly calcareous; clear, irregular boundary.

B3ca—17 to 25 inches, grayish-brown (2.5Y 5/2) silty clay loam; weak, coarse, prismatic and strong, coarse and medium, angular blocky structure; firm when moist, slightly sticky and slightly plastic when wet; strongly calcareous; abrupt, wavy boundary.

Cca—25 to 31 inches, light olive-gray (5Y 6/2) silty clay, olive gray (5Y 4/2) when moist; weak, coarse, angular blocky structure; firm when moist, sticky and plastic when wet; very strongly calcareous, and contains many coarse, prominent nodules of lime that are white (5Y 8/2) when moist; gradual, wavy boundary.

C1—31 to 36 inches, olive-gray (5Y 4/2, moist) silty clay; bedded platy structure; firm when moist, sticky and plastic when wet; strongly calcareous and contains white nodules of lime.

C2—36 to 48 inches (auger sample); olive (5Y 4/3, moist) silty clay; very firm when moist, very sticky and very plastic when wet; calcareous.

The texture of the A horizon ranges from clay loam to clay, and the thickness of that horizon ranges from 2 to 6 inches. In a few places the A horizon is noncalcareous. The texture of the B horizons ranges from silty clay loam to clay. Analysis of physical properties has shown that the content of clay in the B horizons ranges from 40 to 47 percent, by volume. The combined thickness of the B2, B3, and B3ca horizons ranges from 8 to 24 inches. In most places the substratum contains few to many nests of salts. In places a weak crust, 1/8 to 3/8 inch in thickness, covers the surface of these soils. This crust is especially prominent after the surface layer has dried to below field capacity. Chemical analysis of several profiles of Moreau soils indicates that the content of exchangeable sodium increases sharply from less than 15 percent in the A horizon to more than 25 percent in the lower B horizons. In the same B horizons, electrical conductivity increases to 8 or 10 millimhos per centimeter. The pH ranges from 7.1 to 7.7 in the A horizon, but it increases to 8.4 to 9.2 in the B2.

Morton Series

In the Morton series are well-drained, deep, mainly nearly level or gently sloping soils of the Chestnut great soil group. These soils developed on uplands in material weathered from silty shale that is a part of the Fort Union and Golden Valley formations. The lower part of their substratum is less weathered with increasing depth and shows characteristics of the underlying bedded sedimentary rocks. This material breaks easily into horizontal plates 1/16 to 1/8 inch in thickness, and a few vertical cracks extend to a depth of about 60 inches. These are the most extensive soils of the uplands in Stark County. Their slopes range from 1 to 10 percent.

The Morton soils have a thinner solum and slightly lighter colored A and B horizons than the Arnegard and Grail soils. They lack the firm consistence and have less clay in the B and C horizons than the Regent soils. The Morton soils do not have the variably textured substratum that is typical of the Farland soils. They occur with the Chama soils, but they have a more distinct, thicker B horizon than those soils and are noncalcareous at or near the surface.

Typical profile of Morton silt loam 145 feet east and 100 feet north of the southwest corner of the southeast quarter of section 2, T. 139 N., R. 94 W.:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; weak, medium and fine, subangular blocky and moderate, medium, crumb structure; slightly hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; clear, smooth boundary.

B2t—7 to 20 inches, dark grayish-brown (10YR 4/2) weak silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, coarse and medium, prismatic and moderate, medium, angular blocky structure; the surfaces of the peds are covered with clay films that are

very dark brown (10YR 2/2) when moist; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; noncalcareous.

B3ca—20 to 27 inches, light brownish-gray (2.5Y 6/2) silt loam, olive brown (2.5Y 4/4) when moist; moderate, coarse, prismatic and moderate, fine and medium, angular blocky structure; slightly hard when dry, friable when moist, nonsticky and slightly plastic when wet; strongly calcareous.

Cca—27 to 32 inches, pale-olive (5Y 6/3) silt loam, olive (5Y 5/3) when moist; moderate, coarse, angular blocky structure; hard when dry, friable when moist, nonsticky and slightly plastic when wet; very strongly calcareous and contains coarse, prominent nodules of white (2.5Y 8/2) lime; gradual, wavy boundary.

C1—32 to 47 inches, pale-olive (5Y 6/3) silt loam, light olive brown (2.5Y 5/4) when moist; moderate fine and coarse angular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; calcareous.

IIC2—47 to 58 inches, (auger sample); light olive-gray (5Y 6/2) silty clay loam, olive (5Y 5/3) when moist; slightly hard when dry, friable when moist, slightly sticky and plastic when wet; calcareous.

The A horizon ranges from 2 to 8 inches in thickness, and its texture ranges from loam to silt loam or clay loam. The combined B horizons range from 18 to 42 inches in thickness and from loam to silty clay loam in texture.

Parshall Series

The Parshall series consists of well-drained, moderately coarse textured soils of the Chestnut great soil group. These soils developed in sandy alluvium or colluvium and in material weathered from sandstone. They have weakly calcareous to calcareous material in the lower part of the B horizon and in the substratum. Their slopes range from 0 to 6 percent but are mainly between 1 and 3 percent.

The Parshall soils have a thicker and slightly darker colored solum than the Vebar soils. They are finer textured and darker colored than the Lihen soils, and they have a more distinct B horizon than the Lihen soils. The B2 horizon of the Parshall soils is less clearly expressed than that of the Manning soils, and the Parshall soils are not underlain by the thick beds of gravelly material like those underlying the Manning soils. The Parshall soils occur with the Arnegard soils, but throughout the profile their texture is fine sandy loam instead of loam.

Typical profile of Parshall fine sandy loam, 1,230 feet south and 1,010 feet east of the northwest corner of section 13, T. 139 N., R. 94 W.:

A1p—0 to 8 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark brown (10YR 2/2) when moist; weak, fine, subangular blocky structure and single grain; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; noncalcareous; clear, smooth boundary.

B2—8 to 28 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic and moderate, fine and medium, angular blocky structure; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; noncalcareous; gradual, wavy boundary.

B3—28 to 46 inches, dark grayish-brown (2.5Y 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic and moderate, medium, angular blocky structure; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; calcareous; gradual, wavy boundary.

C1—46 to 66 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; moderate, coarse and medium, angular blocky structure; slightly hard when dry, friable when moist, nonsticky and nonplastic when wet; strongly calcareous; abrupt, smooth boundary.

IIC2—66 to 69 inches, gray (10YR 6/1) and yellowish-brown (10YR 5/4) coarse gravel; single grain; nonsticky and nonplastic when wet; calcareous.

The thickness of the A horizon ranges from 8 to 18 inches, and the texture of the A and B horizons is sandy loam in some places. The combined thickness of the B horizons ranges from 15 to 38 inches. In places thin, buried A horizons occur in the solum or substratum. The texture of the C horizons ranges from fine sandy loam to loamy sand or sandy gravel, but the most common texture is fine sandy loam.

Promise Series

In the Promise series are soils of the Chestnut great soil group that are intergrading toward Grumusols. These soils developed in colluvium or in material weathered from clayey shale. They occur on stream terraces and gently sloping uplands and in drainageways. Their slopes are mainly less than 5 percent. Spots or patches where the surface layer has a weak crust appear in many of the areas. Salt is nearer the surface in those spots than in other areas.

Unlike the Moreau soils, the Promise soils have an A1 horizon that is generally noncalcareous. They are slightly finer textured than the Regent and Savage soils.

Typical profile of Promise clay, 180 feet west and 0.35 mile south of the northeast corner of section 31, T. 138 N., R. 97 W. (Sample No. S-58-ND-45-9, Laboratory No. 8532-38: See the section "Physical and Chemical Properties of Soils"):

Ap—0 to 4 inches, olive-gray (5Y 4/2) clay, black (5Y 2/2) when moist; moderate, medium, crumb structure; very hard when dry, friable when moist, very sticky and very plastic when wet; noncalcareous; contains a few fine siliceous pebbles, 1 to 3 millimeters in diameter, and similar pebbles are in the other horizons; clear, smooth boundary.

B2—4 to 8 inches, gray (5Y 5/1) clay, dark olive gray (5Y 3/2) when moist; weak, medium, prismatic structure but breaks to moderate, fine and medium, angular blocky structure; very hard when dry, friable when moist, very sticky and very plastic when wet; calcareous; clear, smooth boundary.

Bca—8 to 19 inches, olive-gray (5Y 5/2) clay, olive gray (5Y 4/2) when moist; weak, medium, prismatic structure but breaks to moderate, fine and medium, angular blocky structure; very hard when dry, friable when moist, very sticky and very plastic when wet; calcareous; clear, wavy boundary.

Cca—19 to 30 inches, light-gray (2.5Y 7/2) clay, light brownish gray (2.5Y 6/2) when moist; weak, medium, angular blocky structure; has patchy, very dark gray (5Y 3/1) clay coats on the surfaces of the peds; very hard when dry, firm when moist, very sticky and very plastic when wet; very strongly calcareous and contains a few, fine, faint threads and nodules of lime; gradual, smooth boundary.

C11 30 to 42 inches, gray (10YR 5/1) clay, light olive brown (2.5Y 5/3) when moist; contains many, medium, prominent mottles of light brownish gray (10YR 6/2); weak, coarse and medium, angular blocky structure; very hard when dry, firm when moist, very sticky and very plastic when wet; strongly calcareous, and contains a few, fine, distinct nodules of lime; clear, wavy boundary.

C12—42 to 52 inches, light brownish-gray (10YR 6/2) clay, light olive brown (2.5Y 5/3) when moist; other characteristics same as those in C11 horizon.

C2—52 to 62 inches, light-gray (5Y 7/2) sandy clay, gray (5Y 5/1) when moist; weak, coarse and medium, angular blocky structure; very hard when dry, firm when moist, very sticky and very plastic when wet; strongly calcareous, and contains a few, prominent, white (2.5Y 8/2) nodules of lime.

The A1 horizon ranges from 2 to 4 inches in thickness and from silty clay loam to silty clay or clay in texture. A B3 or B3ca horizon is present in some places. The total thickness of the B horizons ranges from 15 to 25 inches, and the texture of those horizons is silty clay in some places.

Typical profile of Promise silty clay, 300 feet north and 220 feet west of the southeast corner of section 32, T. 141 N., R. 96 W. (Sample No. S–58–ND–13–1, Laboratory No. 8511–17: See the section "Physical and Chemical Properties of Soils"):

Ap—0 to 6 inches, dark grayish-brown (2.5Y 4/2) silty clay, black (10YR 2/1) when moist; moderate, thick, platy and moderate, medium, crumb structure; very hard when dry, friable when moist, sticky and plastic when wet; noncalcareous; gradual, smooth boundary.

B1—6 to 10 inches, dark grayish-brown (2.5Y 4/2) silty clay loam, very dark grayish brown (2.5Y 3/2) when moist; moderate, medium, prismatic structure but breaks to moderate, fine and medium, angular blocky structure; very dark gray (2.5Y 3/1) clay skins on the tops and vertical surfaces of the peds; very hard when dry, firm when moist, sticky and very plastic when wet; noncalcareous; clear, smooth boundary.

B2—10 to 20 inches, olive (5Y 4/3) silty clay, dark grayish brown (2.5Y 4/2) when moist; moderate, medium, prismatic structure but breaks to moderate, medium, angular blocky structure; hard when dry, firm when moist, sticky and very plastic when wet; very dark grayish-brown (2.5Y 3/2) clay skins on the tops and vertical surfaces of the peds; noncalcareous; abrupt, smooth boundary.

Bca—20 to 34 inches, pale-olive (5Y 6/3) silty clay, very dark grayish brown (2.5Y 3/2) when moist; weak, coarse, prismatic structure but breaks to moderate, coarse and medium, angular blocky structure; extremely hard when dry, firm when moist, sticky and very plastic when wet; contains a few, fine, distinct, white (2.5Y 8/2) nodules of lime; very strongly calcareous; clear, wavy boundary.

C1—34 to 45 inches, olive (5Y 5/3) silty clay, olive (5Y 4/3) when moist; weak, coarse, prismatic structure but breaks to moderate, medium, angular blocky structure; very hard when dry, firm when moist, sticky and very plastic when wet; very strongly calcareous; gradual, smooth boundary.

C2—45 to 54 inches, pale-olive (5Y 6/3) silty clay, olive (5Y 4/3) when moist; moderate, coarse, angular blocky structure; extremely hard when dry, very firm when moist, sticky and very plastic when wet; very strongly calcareous; clear, smooth boundary.

C3—54 to 62 inches, light olive-gray (5Y 6/2) silty clay, olive (5Y 4/3) when moist; other characteristics like those of the C2 horizon.

Typical profile of Promise silty clay, 215 feet north of the S¼ corner of section 35, T. 141 N., R. 92 W. (Sample No. S–58–ND–45–18, Laboratory No. 8587–92: See the section "Physical and Chemical Properties of Soils"):

Ap—0 to 5 inches, dark-gray (5Y 4/1) silty clay, black (2.5Y 2/2) when moist; moderate, very fine, crumb structure; hard when dry, friable when moist, very sticky and very plastic when wet; slightly calcareous. (In about 1 percent of the acreage, the Ap horizon is dispersed.)

B21—5 to 12 inches, olive-gray (5Y 4/2) silty clay, very dark grayish brown (2.5Y 3/2) when moist; has continuous dark-gray (2.5Y 3/1) clay skins on the surfaces of the peds; weak, coarse, prismatic structure but breaks to moderate, fine, angular blocky structure; hard when dry, friable when moist, very sticky and very plastic when wet; strongly calcareous.

B22—12 to 20 inches, description the same as that given for B21 horizon (split for laboratory purposes).

Ccs1—20 to 32 inches, olive-gray (5Y 5/2) silty clay, very dark grayish brown (2.5Y 3/2) when moist; has patches of dark-gray (2.5Y 3/1) clay skins on the vertical surfaces of the peds; very coarse, weak, prismatic structure but breaks to weak, fine, angular blocky structure; extremely hard when dry, firm when moist, very sticky and very plastic when wet; strongly calcareous and contains a few, fine, faint nodules of lime and many prominent nests of light-gray (2.5Y 7/2) gypsum crystals.

Ccs2—32 to 44 inches, description of Ccs2 horizon same as that of the Ccs1, except that many fine, distinct nodules of lime are present.

C—44 to 62 inches, pale-olive (5Y 6/3) silty clay, olive (5Y 5/3) when moist; weak, medium, angular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; very strongly calcareous; has a few gypsum crystals between the peds and in cracks.

Regent Series

In the Regent series are deep, well-drained, nearly level to sloping soils of the Chestnut great soil group. These soils developed in material weathered from stratified soft shale that contains gray and olive silty clay and silty clay loam and is of Tertiary age. They occur in many places in the uplands of Stark County and are considered valuable for agriculture. Their slopes are long and smooth.

The Regent soils occur with the Morton, Grail, Moreau, Rhoades, and Promise soils. They are finer textured than the Morton soils and have a slightly more blocky B2 horizon than those soils. They have thinner, lighter colored A and B horizons than the Grail soils, and they have lime higher in the profile. The Regent soils have a thicker solum, a slightly darker colored A horizon, and lime lower in the profile than the Moreau soils. They lack the characteristics of soils in the Solonetz great soil group that are typical of the Rhoades soils. The Regent soils contain less clay than the Promise soils, and they are less firm than those soils.

Profile of a cultivated Regent silty clay loam, at the northwest corner of section 3, T. 139 N., R. 97 W.:

Ap—0 to 10 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; weak, moderate, subangular blocky (cloddy) to moderate, fine, granular structure; hard when dry, friable when moist, sticky and plastic when wet; noncalcareous; abrupt boundary.

B21—10 to 18 inches, grayish-brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) when moist; weak, coarse, prismatic structure but breaks to strong, fine, angular blocky structure; very dark grayish-brown (2.5Y 3/2) clay films evident on the surfaces of the blocks; very hard when dry, firm when moist, very sticky and plastic when wet; noncalcareous; clear, wavy boundary.

B22—18 to 26 inches, light brownish-gray (2.5Y 6/2) silty clay, olive brown (2.5Y 4/3) when moist; weak, coarse, prismatic structure but breaks to moderate, medium, angular blocky structure; very hard when dry, firm when moist, very sticky and plastic when wet; moderately calcareous and has a few faint spots of segregated lime and a few thin clay films on the surfaces of the blocks; gradual, wavy boundary.

B3ca—26 to 40 inches, pale-olive (5Y 6/3) heavy silty clay loam, olive (5Y 5/3) when moist; very weak, coarse, prismatic structure to moderate, medium, angular blocky structure; very hard when dry, firm when moist, very sticky and plastic when wet; strongly cal-

careous and contains common fine threads and a few nodules of segregated lime; clear, wavy boundary.

C1—40 to 62 inches, pale-olive (5Y 6/3) heavy silty clay loam, olive (5Y 5/3) when moist; weak blocky structure, but platy structure is also evident because of the stratification of the sediments; very hard when dry, firm when moist, very sticky and plastic when wet; strongly calcareous, and contains a few fine threads of segregated lime flour; has a few yellowish-brown (10YR 5/6) mottles of iron oxide.

The A horizon ranges from silty clay loam to clay loam in texture and from 4 to 10 inches in thickness. The B2 and B3ca horizons range from 15 to 30 inches in combined thickness, from dark grayish brown to olive gray or pale olive in color, and from silty clay loam to silty clay in texture. In places parts of the B2 horizons are slightly calcareous. The zone of lime accumulation is in the upper part of the C horizon in some places, instead of in the lower part of the B horizon. Nests of salts are common below the B horizon.

Rhoades Series

The Rhoades series consists of solodized-Solonetz soils that developed in material weathered from alkaline shale of the uplands and in old alluvium on stream terraces. These soils are moderately well drained. They are mainly nearly level and gently sloping, but they are sloping in a few places.

The Rhoades soils occur with the Grail, Morton, Regent, and Farland soils of the Chestnut great soil group. Unlike these associated soils, however, they have a prominent A2 horizon, strong columnar structure in the B2 horizon, and a saline substratum. The Rhoades soils have a thinner A horizon than the Belfield soils. Also, they have salts higher in the profile, and they have columnar instead of prismatic structure in the B2 horizon. The Rhoades soils have a thinner A1 horizon than the Beckton soils, and their A1 and A2 horizons are thinner and finer textured than those of the Beckton soils.

Typical profile of Rhoades loam, 0.15 mile south and 25 feet west of the northeast corner of section 27, T. 137 N., R. 99 W.:

A1—0 to 3 inches, dark grayish-brown (2.5Y 4/2) loam, very dark gray (2.5Y 3/1) when moist; moderate, fine and medium, angular blocky and weak, fine, crumb structure; soft when dry, friable when moist, slightly sticky and nonplastic when wet; noncalcareous; clear, smooth boundary.

A2—3 to 5 inches, grayish-brown (2.5Y 5/2) loam, very dark grayish brown (2.5Y 3/2) when moist; strong, medium, angular blocky and moderate, thin, platy structure; slightly hard when dry, friable when moist, slightly sticky and nonplastic when wet; noncalcareous; clear, smooth boundary.

B21—5 to 11 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 3/2) when moist; strong, medium, columnar and strong, fine, angular blocky structure; peds coated with very dark gray (10YR 3/1) clay; very hard when dry, very firm when moist, sticky and plastic when wet; noncalcareous; gradual, wavy boundary.

IIB22—11 to 16 inches, grayish-brown (2.5Y 5/2) silty clay, very dark grayish brown (2.5Y 3/2) when moist; moderate, medium, prismatic and strong, fine and medium, angular blocky structure; peds coated with dark grayish-brown (2.5Y 4/2) clay films; hard when dry, very firm when moist, sticky and plastic when wet; calcareous; gradual, wavy boundary.

IICcs—16 to 24 inches, light brownish-gray (2.5Y 6/2) clay; dark grayish brown (2.5Y 4/2) when moist; strong, fine and medium, angular blocky structure; extremely hard when dry, firm when moist, sticky and plastic when wet; strongly calcareous; contain many, fine, prominent salt nests; gradual, wavy boundary.

IIIC1—24 to 44 inches, light olive-gray (5Y 6/2) sandy clay loam with yellowish-brown (10YR 5/6) mottles that are olive (5Y 4/3) when moist; massive; extremely hard when dry, firm when moist, sticky and plastic when wet; calcareous, and contains many, fine, prominent salt nests.

IVC2—44 to 60 inches, olive (5Y 4/3) clay; massive; extremely hard when dry, firm when moist, sticky and plastic when wet; slightly calcareous.

The A1 horizon is absent in some places, but it is as much as 3 inches thick in the areas where it is present. The color of the A1 horizon ranges from very dark gray or dark grayish brown to light gray. The A2 horizon ranges from ½ inch to 4 inches in thickness. In a few areas the texture of the A1 and A2 horizons is clay loam. The texture of the B2 horizons ranges from clay loam to silty clay, and those horizons are darker than the A1 in many places. The combined B2 horizons range from 8 to 27 inches in thickness. In many places the profile has a Bca or Bcs horizon below the B2 horizons. The content of exchangeable sodium ranges from 18 to 35 percent in the B2 and upper C horizons.

Savage Series

In the Savage series are deep, moderately well drained, nearly level soils of the Chestnut great soil group. These soils developed in moderately fine textured alluvium. They are on low terraces in the valley of the Knife River.

The Savage soils are finer textured and are calcareous nearer the surface than the Farland and Straw soils. They have a thinner, lighter colored A1 horizon than the Grail soils, and they are coarser textured and have a thicker solum than the Promise and Moreau series. The Savage soils are less well drained and have more variation in the texture, color, and consistence of their substratum than the Regent soils.

Typical profile of Savage silty clay loam, 150 feet north and 320 feet west of the southeast corner of the northeast quarter of section 8, T. 140 N., R. 92 W.:

A1p—0 to 6 inches, grayish-brown (2.5Y 5/2) silty clay loam, very dark gray (10YR 3/1) when moist; moderate, medium, subangular blocky and moderate, fine, granular structure; hard when dry, friable when moist, sticky and plastic when wet; noncalcareous; abrupt boundary.

B2—6 to 12 inches, grayish-brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) when moist; weak, medium, prismatic and moderate angular blocky structure; hard when dry, firm when moist, very sticky and very plastic when wet; noncalcareous; clay films in patches on the surfaces of the peds; clear boundary.

B3ca1—12 to 15 inches, olive (5Y 5/4) silty clay loam, olive brown (2.5Y 4/3) when moist; weak, medium, prismatic and moderate fine, subangular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; strongly calcareous; wavy boundary.

B3ca2—15 to 19 inches, light olive-gray (5Y 6/2) silty clay loam, olive brown (2.5Y 4/3) when moist; weak, medium, prismatic and moderate, fine, subangular blocky structure; very hard when dry, friable when moist; very strongly calcareous; abrupt boundary.

IIBca3—19 to 34 inches, olive-gray (5Y 5/2) silty clay, olive gray (5Y 4/2) when moist; moderate, medium, prismatic and moderate, medium, angular blocky structure; very hard when dry, firm when moist, very sticky and very plastic when wet; very strongly calcareous and contains nodules of lime; has patches of clay films on the surfaces of the prisms; gradual boundary.

IIICca—34 to 52 inches, pale-olive (5Y 6/3) silty clay loam, light olive brown (2.5Y 5/3) when moist; weak, me-

dium, angular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; very strongly calcareous and contains threads of lime.

IVC—52 to 63 inches, pale-olive (5Y 6/3) silt loam, dark grayish brown (2.5Y 4/2) when moist; weak angular blocky structure; slightly hard when dry, friable when moist, slightly sticky and nonplastic when wet; strongly calcareous.

The A horizon ranges from 4 to 8 inches in thickness, and its texture is clay loam in some places. The texture of the B horizons is generally silty clay loam, but it is clay loam or silty clay in places. The combined thickness of the B horizons ranges from 18 to 29 inches. In many places the nests of gypsum are in the lower part of the B horizon and in the C horizons.

Searing Series

Well-drained soils that developed in the uplands over beds of porcelanite (clinkers) are in the Searing series. These soils are in the Chestnut great soil group. They have a zone of lime accumulation immediately above the C horizon. Their substratum is highly stratified and consists of thin layers of yellowish-red, light-red, and red, slightly calcareous and noncalcareous clinkers. The slopes range from 1 to 7 percent, but they are mainly between 2 and 3 percent.

The Searing soils are distinguished from the Wibaux soils by their distinct B2 horizon. They occur with the Morton and Chama soils, but unlike those soils, they have a reddish color and have hard clinkers in the substratum. The Searing soils lack the gravelly substratun that is typical of the Manning soils.

Typical profile of Searing silt loam in native grass, 0.4 mile east and 250 feet north of the southwest corner of section 1, T. 139 N., R. 98 W.:

A1—0 to 4 inches, reddish-brown (5YR 5/4) silt loam, reddish brown (5YR 4/3) when moist; moderate, medium, subangular blocky and moderate, medium, crumb structure; slightly hard when dry, friable when moist, slightly sticky and nonplastic when wet; noncalcareous; clear, smooth boundary.

B2—4 to 10 inches, reddish-yellow (5YR 6/6) silt loam, reddish brown (5YR 5/4) when moist; strong, coarse, prismatic and strong, coarse to fine, angular blocky structure; has patches of clay films on the surfaces of the peds; hard when dry, friable when moist, slightly sticky and nonplastic when wet; noncalcareous; abrupt, smooth boundary.

B3ca—10 to 18 inches, reddish-brown (5YR 5/4) silt loam, yellowish red (5YR 4/6) when moist; moderate, coarse, prismatic and moderate, coarse and medium, angular blocky structure; slightly hard when dry, friable when moist, slightly sticky and nonplastic when wet; strongly calcareous; gradual, wavy boundary.

Cca—18 to 26 inches, reddish-yellow (5YR 6/6) silt loam, red (2.5YR 4/6) when wet; moderate, coarse, angular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous; clear, wavy boundary.

C1—26 to 56 inches, light-red (2.5YR 6/6), hard unconsolidated pieces and large fragments of indurated porcelanite; noncalcareous.

The A1 horizon ranges from 3 to 8 inches in thickness, and its texture is loam in some places. In places the B2 horizon has medium, coarse, prismatic structure, and it has a loam texture in some places. The thickness of the B2 horizon ranges from 6 to 16 inches. In most places a B3 or B3ca horizon underlies the B2 horizon, but the profile lacks this horizon in some places. The thickness of the B3 or B3ca horizon ranges from 3 to 8 inches.

Straw Series

In the Straw series are deep, well-drained soils that have minimal characteristics for inclusion in the Chestnut great soil group. These soils developed in medium-textured alluvium on low terraces and flood plains in the valleys of the Heart and Green Rivers. Their slopes range from 0 to 3 percent, but they are mainly less than 1 percent.

The Straw soils lack the argillic B2t horizon that has continuous clay films on the vertical surfaces of the peds and strong blocky structure that is typical in the profile of the Farland soils. Lime is deeper in their profile than in the profile of the Havre soils, and unlike the Havre soils, they have a B2 horizon. The Straw soils occur with the Parshall and Vebar soils, but they contain less sand than those soils. They contain less clay than the Savage soils.

Typical profile of Straw loam, 30 rods east and 30 rods south of the center of section 22, T. 140 N., R. 95 W. (50 feet north of the bank of the Green River) (Sample No. S–58–ND–45–3, Laboratory No. 8488–95: See the section "Physical and Chemical Properties of Soils"):

A1—0 to 3 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/2) when moist; moderate, medium, crumb and moderate, fine, angular blocky structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; abrupt, smooth boundary.

B1—3 to 12 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine and medium, prismatic structure but breaks to moderate, medium, angular blocky structure; very dark brown (10YR 2/2) clay skins are visible on the tops and vertical surfaces of the peds; very hard when dry, friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; clear, smooth boundary.

B2—12 to 24 inches, olive (5Y 5/3) loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, prismatic structure but breaks to moderate, medium, subangular blocky structure; very dark grayish-brown (10YR 3/2) patches of clay skins cover the tops and vertical surfaces of the peds; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; abrupt, smooth boundary.

B3—24 to 27 inches, pale-olive (5Y 6/3) sandy loam, olive brown (2.5Y 4/4) when moist; weak, medium, angular blocky structure; hard when dry, friable when moist, slightly sticky and nonplastic when wet; noncalcareous; abrupt, smooth boundary.

Cca1—27 to 37 inches, light brownish-gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) when moist; weak, coarse, prismatic structure but breaks to moderate, medium, angular blocky structure; very hard when dry, friable when moist, slightly sticky and slightly plastic when wet; calcareous, and contains a few fine, distinct lime threads; abrupt, smooth boundary.

Cca2—37 to 49 inches, light brownish-gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) when moist; weak, coarse, prismatic structure but breaks to moderate, medium, angular blocky structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous, and many fine, distinct lime threads visible; abrupt, smooth boundary.

IIC2—49 to 51 inches, grayish-brown (2.5Y 5/2) sandy loam, very dark grayish brown (2.5Y 3/2) when moist; weak, coarse, prismatic structure but breaks to moderate, medium, angular blocky structure; slightly hard when dry, friable when moist, slightly sticky and nonplastic when wet; calcareous, and a few faint lime threads visible; abrupt, smooth boundary.

IIIC3—51 to 60 inches, pale-olive (5Y 6/3) loam, dark grayish brown (2.5Y 4/2) when moist; moderate, coarse, subangular blocky structure; hard when dry, friable when

moist, slightly sticky and slightly plastic when wet; calcareous.

The thickness of the A1 horizon ranges from 3 to 8 inches, and the texture of that horizon is silt loam in some places. The thickness of the B2 horizon ranges from 10 to 32 inches, and the grade of structure in the B2 horizon ranges from weak to moderate. In many places the profile contains the A horizon of an old buried soil. Depth to lime ranges from 15 to 30 inches, but it is about 20 inches in many places. In places the profile contains a B3ca instead of a Cca horizon; neither horizon occurs in some profiles. The texture in the stratified part of the substratum ranges from loamy fine sand to fine sandy loam, loam, or silt loam.

Valentine Series

In the Valentine series are sandy, excessively drained Regosols that developed in windblown deposits in the uplands. These soils lack a B horizon, but in many places their substratum contains the former A horizon of an old buried soil. This buried A horizon is thin. It occurs at various depths in the substratum. The slopes range from 3 to 20 percent, but they are mainly between 8 and 12 percent.

The Valentine soils are lighter colored and more sandy than the Vebar, Parshall, and Lihen soils, and they have a thinner solum than those soils. In contrast to the Flasher soils, they have a substratum of loose sand. The Valentine soils are noncalcareous throughout the profile instead of having some calcareous horizons like the Banks soils, and they have a less stratified and more sandy substratum than the Banks soils.

Typical profile of Valentine loamy sand, 155 feet north and 80 feet east of the southwest corner of the northwest quarter of section 26, T. 139 N., R. 97 W.:

A1—0 to 3½ inches, brown (10YR 5/3) loamy sand, very dark grayish brown (10YR 3/2) when moist; weak, medium, crumb structure and single grain; loose when dry and moist; noncalcareous; clear, smooth boundary.

C1—3½ to 62 inches, light olive-brown (2.5Y 5/4) sand, olive brown (2.5Y 4/4) when moist; single grain; loose when dry and moist; noncalcareous.

The A1 horizon ranges from 3 to 8 inches in thickness and from loamy sand or loamy fine sand to sand in texture. The color of the C1 horizon ranges from light brown or light olive brown to dark grayish brown, and the texture of that horizon, like the texture in the A1 horizon, ranges from loamy sand or loamy fine sand to sand.

Vebar Series

The Vebar series consists of moderately sandy soils of the Chestnut great soil group. These soils are on the uplands and on high stream terraces, where they developed in material weathered from soft sandstone and in old, moderately sandy alluvium. Their slopes range from 2 to 14 percent.

The Vebar soils have a thinner A1 horizon and a slightly lighter colored solum than the Parshall soils. Unlike the Flasher soils, they have a distinct B horizon. They are finer textured and are slightly darker colored than the Lihen soils. The Vebar soils occur with the Arnegard and Morton soils, but they have a slightly coarser texture throughout the profile than do those soils, and they have a less distinct B horizon.

Typical profile of Vebar fine sandy loam, 300 feet north and 600 feet east of the center of section 5, T. 139 N., R. 96 W.:

A11—0 to 1½ inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10 YR 3/2) when moist; weak, thin, platy structure; very friable when moist, nonsticky and nonplastic when wet; clear boundary.

A12—1½ to 5½ inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; gradual boundary.

AB—5½ to 8 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 3/3) when moist; weak, coarse, prismatic structure; slightly hard when dry, very friable when moist; gradual boundary.

B21—8 to 15 inches, brown (10YR 5/3) fine sandy loam, dark grayish brown (10YR 4/2) when moist; moderate, coarse, prismatic and weak, coarse and medium, blocky structure; slightly hard when dry, very friable when moist; gradual boundary.

B22—15 to 22 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) when moist; structure same as that in the B21 horion; slightly hard when dry, very friable when moist; gradual boundary.

B23—22 to 31 inches, yellowish-brown (10YR 5/4) fine sandy loam, dark brown (10YR 4/3) when moist; weak, coarse, prismatic and weak, coarse and medium, blocky structure; slightly hard when dry, very friable when moist; thin bands of pebbles at the base of this horizon.

C1—31 to 46 inches, light yellowish-brown (2.5Y 6/4) fine sandy loam, light olive brown (2.5Y 5/4) when moist; massive; soft when dry, very friable when moist; gradual boundary.

C2—46 to 60 inches, light yellowish-brown (2.5Y 6/4) loamy fine sand with a few fine mottles of olive yellow (2.5Y 6/8) and grayish brown (2.5Y 5/2); single grain; loose when moist.

The color of the A horizon ranges from grayish brown to dark grayish brown when the soil is dry, and from very dark grayish brown to dark brown when the soil is moist. The combined thickness of the B horizons ranges from 20 to 36 inches. In some places the substratum contains thin layers of gravelly material.

Wibaux Series

In the Wibaux series are loamy Lithosols developed in beds of reddish porcelanite, or clinkers. These soils are excessively drained and have weak profile development. Their slopes range from 3 to 15 percent.

The Wibaux soils differ from the Searing soils in having a variable A1 horizon and no B horizon. Their substratum of red, hard porcelanite distinguishes them from the Bainville and Midway soils, which have a substratum of soft loam and clay loam.

Typical profile of Wibaux loam, 53 rods west and 40 rods north of the southwest corner of the southeast quarter of section 23, T. 139 N., R. 91 W.:

A1—0 to 11 inches, dark-brown (7.5YR 4/2) loam, dark reddish brown (5YR 3/2) when moist; weak, medium, angular blocky structure and single grain; soft when dry, friable when moist, nonsticky and nonplastic when wet; noncalcareous; abrupt, wavy boundary.

C1—11 to 24 inches, light reddish-brown (2.5YR 6/4) clinker fragments, reddish brown (2.5YR 5/4) when moist; platy and stratified; extremely hard when dry; noncalcareous; abrupt, wavy boundary.

C2—24 to 36 inches, pinkish-gray (7.5YR 7/2) bedded clinkers, pinkish gray (7.5YR 6/2) when moist; extremely hard both when dry and moist; noncalcareous.

The hue and value of the colors in the A1 horizon range from 7.5YR to 5 YR, and the chroma ranges from 3 to 6. The thickness of the A1 horizon ranges from 2 to 5 inches. In some areas the profile contains a transitional AC horizon. In many places the substratum contains thin layers of calcareous soil material.

Physical and Chemical Properties of Soils

The data obtained by physical and chemical analyses for some selected soils in Stark County are given in table 7. Profiles of the selected soils are described in the section "Genesis, Classification, and Morphology of Soils."

The data in table 7 are used by soil scientists to classify soils and to develop concepts of soil genesis. They are also helpful for estimating water-holding capacity, wind erosion, fertility, tilth, and other practical aspects of soil management. The data on reaction, electrical conductivity, and percentage of exchangeable sodium are helpful in evaluating the possibility of reclaiming and managing saline-alkali soils.

Field and laboratory methods

All samples used to obtain the data in table 7 were collected from carefully selected pits. The samples are considered representative of the soil material that is made up of particles less than three-fourths of an inch in diameter. The samples were rolled, crushed, and sieved by hand to remove rock fragments larger than 2 millimeters in diameter. The fraction that consists of particles between 2 millimeters and three-fourths of an inch in diameter is recorded on the data sheets and in table 7 as the percentage greater than 2 millimeters. Unless otherwise noted, all laboratory analyses are made on material that passes the 2-millimeter sieve and are reported on an ovendry basis.

Determinations of particle size were made by the pipette method (*7*, *8*, *9*). The soil reaction of the saturated paste and that of a 1:1 and 1:10 water suspension were measured with a glass electrode. The content of organic carbon was determined by wet combustion, using a modification of the Walkley-Black method (*10*). The calcium carbonate equivalent was determined by measuring the volume of carbon dioxide emitted from the soil samples treated with concentrated hydrochloric acid. The cation exchange capacity was determined by direct distillation of absorbed ammonia (*10*).

To determine the extractable calcium and magnesium, calcium was separated as calcium oxalate, and magnesium was separated as magnesium ammonium phosphate (*10*). Extractable sodium and potassium were determined on original extracts with a flame spectrophotometer. The methods of the U.S. Salinity Laboratory were used to obtain the saturation extract (*11*). Soluble sodium and potassium were determined on the saturation extract, using a flame spectrophotometer.

General Nature of the County

This section briefly discusses the history of the county and gives facts about the physical features, minerals, and climate. It also describes the agriculture.

The county was settled mainly in the eighties after the Northern Pacific Railroad had reached the eastern part of the county in 1881. In 1883 the town of Dickinson (originally called Pleasant Valley) was designated as the county seat. For 2 or 3 years after Dickinson was established, it served mainly as a base of operations for construction workers who were building the railroad and as a shipping point for buffalo meat, hides, and cattle. As late as 1883, buffalo could be seen near the town and deer and antelope were plentiful.

Most of the large ranches in the area were established west and north of Stark County, along the rough land bordering the Little Missouri River. Between 1890 and 1907, most of Stark County was divided into tracts, 160 acres in size. During that period, the unfenced range disappeared in most of the county, but only a small acreage of range was plowed before 1895. On most of the farms, livestock was raised and small grains were grown.

Farm operators soon found it uneconomical to farm a unit as small as 160 acres, and about 1910 they began to combine farms by purchasing adjacent tracts. The trend toward larger farms increased, especially after the depression and drought of the thirties. Also, more efficient farming methods and better machinery have been a factor toward establishing larger farms. At present, a typical livestock and grain farm ranges from 800 to 1,200 acres in size, but the average-sized farm is about 843 acres.

The county had a population of 18,451 in 1960. The principal trading point for all of the county and the six adjoining counties is Dickinson. That town, as well as Belfield, Richardton, and other towns and rural areas, are served by Interstate Highway No. 94, which runs east and west, and by U.S. Highway No. 85, which runs north and south. Two State highways, 8 and 22, also run north and south and provide a good network of hard-surfaced primary roads. All-weather county roads provide an access to most of the farms and ranches. A main-line railroad parallels Interstate Highway No. 94 and provides daily freight service to eastern markets at Fargo and the Twin Cities. Several daily passenger trains provide fast transportation to the east and west coasts, and an airline provides passenger service to Bismarck and other points outside the county.

Physical Features

Before geologic erosion became extensive, the area that is now Stark County was apparently a nearly level plain. Now, however, the bottom lands along the streams are about 500 feet lower than the summit of the several buttes. The bottom lands along the Heart River in the southeastern part of the county, for example, are at an elevation of 2,200 feet. The top of Dobson Buttes, southeast of Dickinson, is about 500 feet higher, or at an elevation of 2,699 feet. A benchmark at the Northern Pacific Railroad depot in Dickinson shows an elevation of 2,417 feet.

The elevation increases gradually from the eastern part of the county to the western part, and the western edge of the county is about 200 feet higher than the eastern edge. In the upland areas the slopes are long and terminate at a drainageway or stream.

Minerals

Some parts of the county are underlain by minerals of economic value. Valuable minerals that lie near the surface are clay shale, used in the manufacture of tile, and lignite coal. It has been estimated that more than 20,000 millions short tons of lignite coal underlie the county (*4*). Some areas have been explored to see whether certain strata of the Golden Valley formation can be used as a source of alumina, an aluminum oxide mineral (*5*).

Crude oil has been discovered near Dickinson. It is now pumped from two wells, but several sites were found to be dry and have been abandoned. The crude oil is transported by truck to refineries at Williston, in Williams County, and to Glendive, Mont.

Climate [5]

The climate of Stark County is continental. This type of climate is characterized by extreme fluctuations in temperature. Cold waves and blizzards are common in winter, and warm, sunny days and cool nights are to be expected in summer. The county is located in the rain shadow of the Rocky Mountains and is semiarid. The average annual precipitation is only about 15½ inches, but as little as 7 inches has been received, and as much as 31 inches. More than 75 percent of the annual precipitation falls during the growing season of April through September. As much as 10 inches of precipitation has fallen in June, the wettest month of the year. Most of the precipitation falls during thunderstorms.

Table 8 gives more detailed information about the temperature and precipitation in this county. The information given in this table is based on records kept at the Dickinson Experiment Station. This station has such a long series of excellent and homogenous weather observations that it has been included in the U.S. Weather Bureau's climatological benchmark network. Local differences in relief may cause minor differences in climate, but in general, the data given in table 8 are typical for the entire county.

Precipitation.—Precipitation of 0.01 inch or more in any 1 day can be expected on an average of 86 times each year, and as much as 0.1 inch or more can be expected on an average of 37 times. Table 9, prepared under the North Central Regional Project NC–26, shows the probability of receiving more or less than a given amount of precipitation in a given period during the growing season. According to the figures shown in table 9, the probability of receiving 0.2 inch or more of precipitation in 1 week is greatest during the week of June 7 to 13, when the percent chance is estimated to be 82.8, or approximately 8 years in 10. The probability of receiving 0.2 inch or more of precipitation in a 3-week period is greatest during the period June 14 to July 4, when the percent chance is estimated to be 99.3, or nearly every year.

About once in 2 years, rainfall of the following intensities is likely to be received: 0.80 inch in 30 minutes, 1.05 inches in 1 hour, 1.20 inches in 2 hours, 1.25 inches in 3 hours, 1.50 inches in 6 hours, 1.70 inches in 12 hours, and 1.90 inches in 24 hours (*18*).

The amount of snow received annually ranges from about 12 inches to about 74 inches, but the yearly average is nearly 32 inches. Occasionally, no measurable precipitation is received during a month in winter, and only about 12 percent of the measurable precipitation falls during the winter months of November through February. Nevertheless, a measurable amount of snow can be expected every year in the months of November through March. A measurable amount can be expected 2 years in 3 in October and 5 years in 7 in April. Table 8 shows the average number of days per month when there is a snow cover.

Figure 19 gives some idea of the moisture balance in the county. The data for pan evaporation are for the period 1907–54. A sunken pan, 6 feet in diameter, was used for the experiments, which were made at the Dickinson Experiment Station. The potential evapotranspiration was estimated according to the Thornthwaite method (*13*). During the growing season of April through September, the total amount of precipitation is 12.08 inches, the amount of pan evaporation is 34.53 inches, and the Thornthwaite estimate of potential evapotranspiration is 21.60 inches. The true potential evapotranspiration figure is probably somewhere between the latter two figures and closer to the former.

Temperature.—The average temperature for the 3 summer months of June through August is about 66° F., and the average temperature for the 3 winter months of December through February is about 14°. A temperature of 90° or higher occurs on an average of about 22 days each year, but a temperature of 100° or higher occurs only two or three times a year, and some years not at all. The temperature drops to below zero on an average of about 46 times each year, but above-freezing temperatures occur about 36 times during the same period.

Table 10 shows the probabilities of the last damaging cold temperature in spring and the first in fall. It shows, for example, that there is a 25-percent chance that a temperature of 32° or lower will occur after May 27,

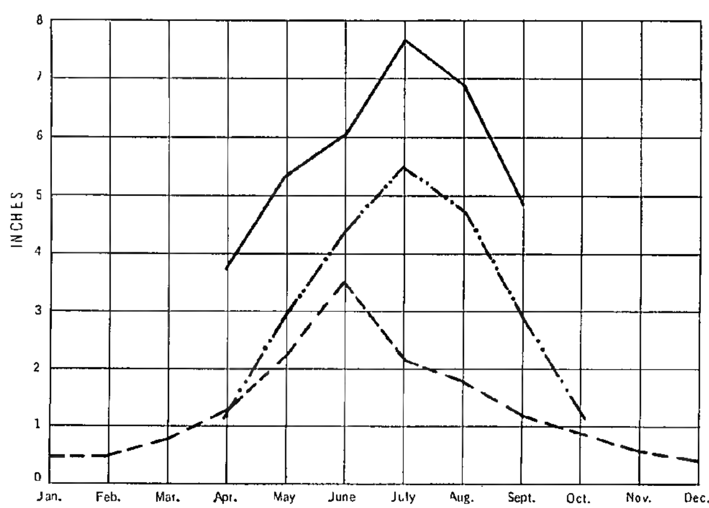

Figure 19.—**Precipitation, pan evaporation, and potential evapotranspiration in Stark County, N. Dak. The dashed line shows the amount of precipitation, the broken line with intermittent dots shows the amount of potential evapotranspiration, and the unbroken line shows the amount of pan evaporation.**

[5] By ALFRED A. SKREDE, State Climatologist, U.S. Weather Bureau, Bismarck, N. Dak.

TABLE 7.—*Physical and chemical*

[Analysis made at Soil Survey Laboratory, Lincoln, Nebr.

Soil type, location, sample number, and laboratory number	Horizon	Depth	Particle-size distribution (in millimeters)							Textural class USDA
			Very coarse sand (2.0–1.0)	Coarse sand (1.0–0.5)	Medium sand (0.5–0.25)	Fine sand (0.25–0.10)	Very fine sand (0.10–0.05)	Silt (0.05–0.002)	Clay (<0.002)	
Arnegard loam:		*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	
Location: 300 ft. S.	Ap	0–5	0.2	1.2	5.6	19.2	10.4	38.8	24.6	Loam
and 0.35 mi. E. of	A1	5–11	.1	.8	5.6	18.7	10.1	38.5	26.2	Loam
the NW. corner of	B21	11–20	.2	1.3	8.0	27.0	10.9	29.1	23.5	Loam
sec. 5, T. 139 N., R.	B22	20–29	.1	1.4	9.4	35.5	14.6	21.4	17.7	Fine sandy loam
94 W.	B3	29–37	.1	1.6	10.0	37.2	17.8	18.0	15.4	Fine sandy loam
Sample No.: S-58ND-	Ab	37–43	.2	2.3	11.9	35.8	14.2	20.2	15.4	Fine sandy loam
45-15.	Bb1	43–48	.3	1.8	11.0	33.8	13.9	22.2	17.0	Fine sandy loam
Laboratory No.: 8578–	Bb2	48–53	.1	1.8	11.8	40.9	13.5	17.2	14.7	Fine sandy loam
86.	C1	53–64	.2	2.2	16.5	52.3	11.7	7.8	9.3	Loamy fine sand
Bainville silt loam:										
Location: 220 rods E.	A1	0–2	.3	.6	.8	22.6	20.9	40.8	14.0	Loam
and 140 rods S. of the	ACca	2–6	.2	.3	.4	6.7	7.0	61.9	23.5	Silt loam
W¼ corner of sec. 28,	Cca	6–12	.1	.2	.1	1.4	3.0	69.7	25.5	Silt loam
T. 140 N., R. 92 W.	C1	12–18	<.1	.2	.1	.4	.8	73.8	24.8	Silt loam
Sample No.: S-58ND-	C2	18–34	<.1	.1	>.1	.5	.6	77.4	21.4	Silt loam
45-12.	C3	34–41	.1	.1	>.1	.5	3.6	73.0	22.8	Silt loam
Laboratory No.: 8554–	C4	41–56	.1	<.1	>.1	.5	.6	65.0	33.9	Silty clay loam
61.	C5	56–59	.1	.3	>.1	1.2	22.2	69.3	6.9	Silt loam
Farland silt loam:										
Location: 1,350 feet	A1	0–3	.1	.6	1.9	6.2	8.1	57.9	25.2	Silt loam
W. and 220 ft. N. of	B21	3–7	.2	.4	1.2	4.2	6.6	53.8	33.6	Silty clay loam
the S¼ corner of sec.	B22	7–15	.1	.3	1.3	5.3	7.8	49.7	35.5	Silty clay loam
28, T. 141 N.,	B23	15–25	<.1	.2	.8	7.8	12.8	45.0	33.4	Clay loam
R. 93 W.	C1ca	25–31	<.1	.2	1.0	7.4	10.0	50.5	30.9	Silty clay loam
Sample No.: S-58	C2ca	31–39	<.1	.1	1.5	5.6	5.8	52.7	34.3	Silty clay loam
ND-45-20.	C3ca	39–47	<.1	.2	1.6	5.7	6.8	49.3	36.4	Silty clay loam
Laboratory No.:	C4	47–54	<.1	.2	1.2	5.1	7.0	53.3	33.2	Silty clay loam
8600–08.	C5	54–60	<.1	.3	2.0	6.4	6.8	44.2	40.3	Silty clay
Lefor sandy loam:										
Location: 300 ft. E.	Ap	0–6	.1	5.0	19.6	37.3	8.2	18.0	11.8	Fine sandy loam
and 85 ft. N. of the	B1	6–15	.1	4.2	20.0	37.5	9.2	17.5	11.5	Fine sandy loam
W¼ corner of sec. 13,	B2	15–24	.2	4.7	21.1	26.6	6.8	18.1	22.5	Sandy clay loam
T. 137 N., R. 95 W.	BCca	24–36	1.0	5.8	21.8	18.3	5.1	27.6	20.4	Sandy clay loam
Sample No.: S-58ND-	C1	36–47	.7	5.9	18.0	21.5	5.6	28.5	19.8	Loam
45-21.	Ccs	47–53	1.0	7.6	17.3	20.5	5.7	27.8	20.1	Sandy clay loam
Laboratory No.: 8609–	C2	53–58	.9	6.6	13.3	24.1	6.7	28.7	19.7	Loam
16.	C3	58–63	1.0	8.0	19.2	22.5	4.8	27.2	17.3	Sandy loam
Manning fine sandy loam:										
Location: 200 ft. W.	A1	0–3	3.9	5.5	9.6	23.2	9.1	30.9	17.8	Loam
and 1,510 ft. S. of	B2	3–13	3.5	4.2	12.2	32.6	9.2	18.3	20.0	Silty clay loam
the E¼ corner of sec.	Cca	13–19	2.2	3.7	14.3	38.0	7.0	13.7	21.1	Silty clay loam
11, T. 139 N., R. 97 W.	IIC1	19–28	19.1	15.0	17.0	27.5	5.8	7.7	7.9	Loamy coarse sand.
Sample No.: S-59ND-45-5.	IIC2	28–41	26.0	18.8	16.0	17.0	3.5	8.3	10.4	Loamy coarse sand.
Laboratory No.: 8504–	IIIC3	41–47	1.3	3.8	9.0	20.8	18.8	30.2	16.1	Fine sandy loam
10.	IVC4	47–60	4.1	29.0	39.1	21.4	1.3	2.3	2.8	Coarse sand
Promise clay:										
Location: 180 ft. W.	Ap	0–4	5.1	6.9	3.8	5.2	3.3	29.1	46.6	Clay
and 0.35 mi. S. of	B2	4–8	2.7	6.0	4.0	5.0	2.8	29.0	50.5	Clay
the NE. corner of	Bca	8–19	3.5	6.4	3.6	3.9	2.3	29.2	51.1	Clay
sec. 31, T. 138 N.,	Cca	19–30	3.7	5.8	2.8	3.4	2.1	31.7	50.5	Clay
R. 97 W.	C11	30–42	2.1	5.5	3.5	4.3	2.7	32.0	49.9	Clay
Sample No.: S-58ND-	C12	42–52	2.5	5.9	3.7	4.5	2.8	32.2	48.4	Clay
45-9.	C2	52–62	3.0	6.6	3.8	4.2	2.5	30.4	49.5	Clay
Laboratory No.: 8532–38.										

properties of selected soils

Dashes indicate values not determined or do not apply]

pH		Organic carbon	Nitrogen	Ratio C/N	Electrical conductivity (Ecx103)	Calcium carbonate equivalent	Cation-exchange capacity (NH4AC)	Extractable cations					Exchangeable sodium	Moisture at saturation
1:1	1:10							Ca	Mg	H	Na	K		
		Percent	*Percent*			*Percent*	*Meq./100 gr.*						*Percent*	*Percent*
5.7	6.2	3.28	0.267	12.3	0.7	----------	24.8	14.9	3.6	9.8	<0.1	1.8	----------	54.3
6.0	6.5	2.25	.184	12.2	.5	----------	22.7	14.2	4.0	7.9	.1	1.4	----------	49.7
6.2	6.8	1.01	.096	10.5	.4	----------	17.0	10.5	3.6	4.6	.1	1.2	----------	39.7
6.3	6.9	.59	.058	10.0	.4	----------	12.4	7.6	2.9	3.2	.1	.9	----------	32.9
6.4	7.0	.49	--------	------	.4	----------	10.8	6.7	2.5	2.7	.1	.8	----------	33.9
6.5	6.9	.55	--------	------	.4	----------	11.1	7.1	2.7	3.2	.1	.9	----------	32.1
6.3	6.9	.48	--------	------	.4	----------	11.5	7.4	2.8	2.8	.1	.8	----------	36.0
6.4	6.9	.30	--------	------	.5	----------	9.6	6.1	2.6	1.8	.1	.6	----------	35.5
6.5	7.0	.18	--------	------	.5	----------	6.9	4.4	1.8	1.4	.1	.4	----------	31.4
7.8	8.4	3.41	.305	11.2	.8	3	17.0	------	------	------	<.1	.7	----------	88.4
8.0	8.8	2.46	.212	11.6	.8	22	14.2	------	------	------	<.1	.6	----------	80.9
8.4	9.1	.85	.061	14.0	.6	21	9.8	------	------	------	.1	.3	1	59.8
8.7	9.4	.26	.026	10.0	.7	19	9.9	------	------	------	.2	.4	1	59.0
8.9	9.5	.13	.014	------	.7	16	10.3	------	------	------	.7	.4	5	61.9
9.1	9.9	.09	--------	------	.7	14	11.4	------	------	------	2.0	.4	17	67.3
9.0	9.8	.11	--------	------	.7	13	12.2	------	------	------	2.9	.4	20	97.2
9.5	10.0	.07	--------	------	.9	16	4.8	------	------	------	1.3	.1	21	47.3
6.0	6.4	4.28	.354	12.1	.4	----------	22.6	12.5	5.0	8.8	<.1	1.1	----------	76.9
6.1	6.6	2.37	.194	12.2	.4	----------	24.8	14.1	7.2	6.1	.1	.9	----------	56.1
6.5	7.1	1.43	.132	10.8	.5	----------	25.3	14.0	9.0	4.2	.1	.8	2	55.2
7.3	7.9	.98	.093	10.0	.6	----------	24.0	13.2	11.0	1.9	.6	.5	4	54.2
8.4	9.3	.82	--------	------	.8	5	19.7	------	------	------	1.1	.3	9	53.2
8.7	9.5	.77	--------	------	.9	5	20.4	------	------	------	2.2	.3	12	62.8
8.7	9.6	.60	--------	------	.9	5	21.1	------	------	------	3.0	.3	12	68.6
8.6	9.6	.63	--------	------	1.5	4	20.8	------	------	------	3.2	.4	10	68.0
8.2	9.1	.83	--------	------	3.8	2	23.9	------	------	------	4.1	.5	----------	71.9
5.6	6.1	.91	.081	11	.6	----------	6.8	3.7	1.0	3.2	<.1	.2	----------	----------
6.4	6.7	.42	.040	10	.5	----------	4.8	3.8	1.2	1.8	.1	.1	----------	----------
7.1	7.5	.40	.047	8	.5	----------	4.6	3.0	3.8	1.4	.1	.1	----------	----------
8.4	9.1	.17	--------	------	.5	6	4.3	------	------	------	.1	.1	----------	----------
8.2	8.8	.10	--------	------	1.0	4	4.3	------	------	------	.1	.1	----------	----------
7.9	8.1	.05	--------	------	2.7	2	4.2	------	------	------	.1	.1	----------	----------
7.7	8.1	.02	--------	------	2.7	1	4.9	------	------	------	.1	.1	----------	----------
7.8	8.4	.01	--------	------	2.6	1	4.8	------	------	------	.1	.1	----------	----------
6.6	7.0	2.34	.202	11.6	.5	----------	17.1	11.6	2.8	3.7	<.1	.8	----------	48.3
7.2	7.6	1.18	.094	12.6	.4	----------	18.0	14.3	3.5	1.9	<.1	.2	----------	45.2
8.2	8.9	.90	.081	11.0	.5	10	12.4	------	------	------	<.1	.1	----------	47.4
8.3	9.0	.74	.044	17.0	.6	2	9.5	------	------	------	.1	.1	----------	30.5
8.4	9.0	1.73	--------	------	.7	3	15.0	------	------	------	.1	.1	----------	32.0
8.7	9.3	.37	--------	------	.6	4	11.3	------	------	------	.2	.2	----------	39.8
8.9	9.4	.04	--------	------	.5	----------	3.5	------	------	------	.1	.1	----------	28.4
7.7	8.5	1.14	.113	10.1	.6	1	40.7	------	4.4	<.1	.9	1.2	2	77.1
8.0	9.0	.76	.070	11.0	.5	3	42.7	------	------	------	2.4	.5	5	92.7
8.1	9.1	.63	.059	11.0	.8	4	41.5	------	------	------	3.8	.4	8	90.0
8.2	9.3	.40	.040	10.0	.9	3	43.9	------	------	------	6.5	.8	13	95.6
8.3	9.4	.43	--------	------	1.1	2	42.8	------	------	------	6.7	1.1	14	83.9
8.3	9.4	.37	--------	------	1.3	3	41.7	------	------	------	6.1	1.1	13	86.0
8.1	9.3	.37	--------	------	1.5	4	41.4	------	------	------	6.2	1.2	14	85.1

TABLE 7.—*Physical and chemical*

Soil type, location, sample number, and laboratory number	Horizon	Depth	Particle-size distribution (in millimeters): Very coarse sand (2.0–1.0)	Coarse sand (1.0–0.5)	Medium sand (0.5–0.25)	Fine sand (0.25–0.10)	Very fine sand (0.10–0.05)	Silt (0.05–0.002)	Clay (<0.002)	Textural class USDA
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	
Promise silty clay:										
Location: 300 ft. N.	Ap	0–6	.5	.3	.3	3.3	7.2	47.9	40.5	Silty clay
and 220 ft. W. of the	B1	6–10	.1	.2	.3	3.7	7.5	47.2	41.0	Silty clay
SE. corner of sec. 32,	B2	10–20	.2	.2	.2	4.4	9.5	45.5	40.0	Silty clay
T. 141 N., R. 96 W.	Bca	20–34	.4	.3	.2	2.8	7.4	52.8	36.1	Silty clay loam
Sample No.: S-58ND-13-1.	C1	34–45	.1	.1	.1	1.0	1.8	55.4	41.6	Silty clay
Laboratory No.: 8511-17.	C2	45–54	<.1	.1	<.1	.5	.8	55.4	43.2	Silty clay
	C3	54–62	<.1	.1	<.1	.4	.9	54.0	44.7	Silty clay
Location: 215 ft. N. of the S¼ corner of sec.	AP	0–5	<.1	.2	.6	2.7	4.8	46.2	45.5	Silty clay
35, T. 141 N., R. 92 W.	B21	5 12	<.1	.1	.4	2.2	3.7	45.8	47.8	Silty clay
Sample No.; S-58ND-45-18.	B22	12–20	<.1	<.1	.2	1.0	1.9	44.4	52.5	Silty clay
Laboratory No.: 8587-92.	Ccs1	20–32	<.1	<.1	.3	1.3	1.6	41.8	55.0	Silty clay
	Ccs2	32–44	<.1	<.1	.6	2.1	2.0	43.5	51.8	Silty clay
	C	44–62	<.1	<.1	.5	2.7	3.4	52.7	40.7	Silty clay
Straw loam:										
Location: 30 rods E.	A1	0–3	.9	1.3	4.5	16.7	17.1	38.7	20.8	Loam
and 30 rods S. of the	B1	3–12	.2	1.7	5.5	19.2	16.0	36.3	21.1	Loam
center of sec. 22, T. 140 N., R. 95 W.	B2	12–24	.1	2.1	9.1	26.5	16.8	29.7	15.7	Fine sandy loam
Sample No.: S-58ND-45-3.	B3	24–27	.2	8.1	13.3	38.2	12.2	17.4	10.6	Fine sandy loam
Laboratory No.: 8488-95.	Cca1	27–37	.1	1.1	8.3	26.9	16.5	29.8	17.3	Fine sandy loam
	Cca2	37–49	.2	.7	3.6	21.1	20.6	35.7	18.1	Loam
	IIC2	49–51	3.7	5.1	11.4	35.3	17.2	16.6	10.7	Fine sandy loam
	IIIC3	51–60	.4	.7	1.6	15.0	32.7	32.0	17.6	Loam

that is, once in 4 years a temperature of 32° or lower will occur after May 27. The average date of the last temperature of 32° or lower in spring is May 20,[6] and the average date of the first temperature of 32° or lower in fall is September 19. The average length of the freeze-free period is 122 days. The information in table 10 is based on temperatures taken in an instrument shelter. Frost may occur on the ground at a shelter temperature higher than 32°.

Storms.—On the average, thunderstorms occur on 30 to 35 days each year, and hail generally falls on 2 or 3 of these days. According to U.S. Weather Bureau records kept at Bismarck, N. Dak., 17 percent of the total number of hailstorms occurs in May, 33 percent in June, 20 percent in July, 18 percent in August, 7 percent in September, and 5 percent in the 3 months combined of March, April, and October.

This county is in an area where damage from hail is great. The county ranks fifth in the State in the amount of insured acreage on which crops have been reported damaged. Figure 20 shows the percentage of insured acreage on which 5 percent or more of the crop was damaged during the period 1941 to 1961. The amount of damage to crops, caused by hailstorms, fluctuates widely from year to year. It has ranged from 2 to 62 percent of the insured acreage, but the average percentage is 25.99. The estimates of hail damage given in figure 20 are based on records kept by the State Hail Insurance Department of the State of North Dakota.

Wind.—Table 11 shows the average monthly and annual hours of wind, by velocity groups (miles per hour). The data are from records kept at Dickinson, N. Dak. They were summarized from records kept over a period of 3 years from 1936–38, using an instrument 30 feet above the ground. Winds that erode unprotected soils occur 34 percent of the time, or 2,972 hours annually. Such winds blow approximately 253 hours in April, 326 hours in May and 248 hours in June—months when the fields have only a sparse cover of plants. The velocity of the wind is less than 4 miles per hour 629 hours of the year. Winds of more than 47 miles per hour have not been recorded.

Winds are from the northwest about 1,373 hours annually. They blow from that direction a greater number of hours during the period September to May than at other times. Winds are from the southeast 812 hours

[6] SANDERSON, C. J. THE PROBABILITY OF FREEZING TEMPERATURES IN SPRING AND FALL IN NORTH DAKOTA. (Unpublished manuscript.)

properties of selected soils—Continued

pH		Organic carbon	Nitrogen	Ratio C/N	Electrical conductivity (Ecx103)	Calcium carbonate equivalent	Cation-exchange capacity (NH4AC)	Extractable cations					Exchangeable sodium	Moisture at saturation
1:1	1:10							Ca	Mg	H	Na	K		
		Percent	*Percent*			*Percent*	*Meq./100 gr.*						*Percent*	*Percent*
6. 1	6. 6	2. 11	. 219	9. 6	2. 9	---	27. 8	19. 1	6. 8	5. 2	<. 1	1. 8	---	62. 0
6. 6	7. 1	1. 52	. 145	10. 5	. 5	---	27. 4	18. 6	7. 6	4. 3	. 1	. 5	---	64. 3
7. 1	7. 5	1. 11	. 109	10. 2	. 4	---	25. 7	16. 7	8. 6	2. 8	. 1	. 4	---	58. 7
8. 3	9. 1	. 83	. 084	10. 0	. 5	8	21. 1	---	---	---	. 8	. 2	3	56. 4
8. 7	9. 5	. 51	---	---	. 7	11	19. 9	---	---	---	2. 8	. 2	12	88. 0
8. 7	9. 7	. 38	---	---	1. 1	12	18. 6	---	---	---	3. 8	. 2	15	130. 7
8. 5	9. 5	. 32	---	---	2. 0	8	20. 0	---	---	---	5. 5	. 3	18	134. 2
8. 1	8. 7	1. 40	. 134	10. 4	. 7	2	25. 7	---	---	---	. 2	1. 2	1	60. 8
8. 2	9. 1	1. 06	. 101	10. 5	. 7	4	25. 2	---	---	---	1. 1	. 6	4	65. 9
8. 5	9. 4	. 78	. 063	12	. 8	5	26. 2	---	---	---	2. 2	. 5	7	84. 6
8. 0	8. 5	. 65	. 044	15	5. 2	4	26. 3	---	---	---	3. 9	. 6	10	86. 3
8. 0	8. 5	. 59	---	---	7. 0	4	24. 4	---	---	---	6. 7	. 6	12	92. 3
8. 4	9. 6	. 42	---	---	4. 2	6	20. 9	---	---	---	9. 1	. 4	24	127. 3
6. 3	6. 7	3. 14	. 272	11. 5	. 7	---	22. 2	14. 6	4. 4	3. 9	<. 1	1. 7	---	55. 9
7. 0	7. 4	1. 81	. 157	11. 5	. 5	---	19. 1	14. 2	4. 5	2. 9	. 1	. 8	---	46. 7
7. 7	8. 1	. 98	. 089	11. 0	. 6	---	14. 4	11. 2	4. 2	. 5	<. 1	. 3	---	40. 7
8. 1	8. 9	. 55	---	---	. 6	2	9. 6	-	3. 3	<. 1	<. 1	. 2	--	36. 0
8. 2	9. 0	. 81	---	---	. 8	2	13. 2	---	---	---	. 1	. 3	---	43. 7
8. 4	9. 1	. 84			. 8	4	13. 2	---	---	---	. 3	. 3	---	44. 8
8. 5	9. 2	. 87	---	---	. 9	2	10. 2	---	---	---	. 3	. 2	---	35. 7
8. 4	9. 1	. 69	---	---	1. 2	4	12. 4	---	---	---	. 5	. 2	---	45. 2

annually. They blow from that direction a greater number of hours during the period May through July than at other times. Winds from the south blow throughout the year. They blow from the south a total of 849 hours annually. Winds from the west also blow throughout the year. They blow from 100 to 150 hours per month during the months of October through March. Winds from the west blow about 13 percent of the time, or approximately 1,155 hours per year.

Agriculture

In 1959 Stark County had a total of 1,047 farms, and the average-sized farm was 843 acres. Crops were harvested from 334,772 acres; 113,252 acres was in cultivated summer fallow; 358,660 acres was in pasture; and an additional 14,015 acres was in cropland used only for pasture. The following paragraphs give facts about the agriculture in the county. The figures used are based mainly on statistics of the U.S. Bureau of the Census.

Crops.—Corn, wheat, barley, oats, and hay are the main crops grown in Stark County. Hard red spring wheat is grown on the largest acreage; it was grown on 138,808 acres in 1959. This crop is generally planted in fields that have been summer fallowed or used for corn the previous year. Applying a fertilizer high in content of nitrogen and phosphorus is an accepted practice where wheat is grown. Between the stooling and heading stages of growth, the crop is sprayed to control insects and weeds. During the past few years, a deep-furrow drill has been used in many areas for planting wheat. This crop is highly susceptible to damage from rust.

Corn for all purposes was grown on 51,674 acres in 1959. It is a feed crop that provides winter roughage for livestock, mainly beef cattle. The crop is harvested as ensilage just prior to or during the first period of freezing weather. The chopped stalks, leaves, and ears are stored in pits and in piles above the ground.

Oats and barley were harvested on a total of 56,838 acres in 1959. These feed crops usually follow wheat that has been seeded after summer fallow. Many farmers, however, plant them in fields that have been summer fallowed or in fields that have been used the previous year for corn. The acreage of these crops varies from year to year, depending mainly on the incentive offered by government wheat and feed-grain programs. Some of the barley is marketed for use by the brewing industry. The use of fertilizer on these two crops has become fairly widespread.

Hay was cut on 77,430 acres in 1959. This crop is necessary where livestock are to be fed. Farmers and

TABLE 8.—*Temperature and precipitation*

[All data from records kept at the Dickinson Experiment Station, Dickinson, Stark County, N. Dak.]

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	2 years in 10 will have at least 4 days with—		Average total	1 year in 10 will have—		Average number of days with snow cover	Average depth of snow on days when there is a snow cover
			Maximum temperature equal to or higher than—	Minimum temperature equal to or lower than—		Less than—	More than—		
					Inches	*Inches*	*Inches*		*Inches*
January	23	1	44	−26	0.44	0.07	0.90	22	4
February	25	2	47	−23	.44	.12	.90	21	6
March	36	14	62	−11	.74	.20	1.25	14	4
April	55	28	76	16	1.24	.30	2.40	3	3
May	66	39	84	27	2.20	.50	3.75	(1)	
June	75	49	92	37	3.50	1.25	6.50	0	
July	84	54	97	43	2.17	.60	3.75	0	
August	82	52	97	40	1.78	.50	3.10	0	
September	71	41	90	28	1.19	.20	2.50	(1)	
October	58	31	79	17	.85	.20	2.25	1	2
November	40	18	61	−11	.55	.10	1.25	8	2
December	28	6	49	−20	.40	.10	1.00	15	2
Year	54	28	[2] 101	[3] −32	15.50	11.50	20.00	84	

[1] Less than 1 day.
[2] Average annual highest temperature.
[3] Average annual lowest temperature.

TABLE 9.—*Chance, in percent, of receiving the stated amounts of precipitation during the periods indicated*

1-week period	Probability of receiving at least—				
	Trace or none	0.20 in.	0.60 in.	1.00 in.	2.00 in.
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*
March 29–April 4	25.5	31.6	6.5	1.4	0
April 5–April 11	23.6	35.3	8.8	2.3	0
April 12–April 18	23.6	39.9	15.4	6.4	.5
April 19–April 25	13.8	47.7	20.0	8.9	.9
April 26–May 2	15.7	57.8	26.5	12.1	1.7
May 3–May 9	17.7	46.4	22.5	11.8	2.6
May 10–May 16	5.9	57.0	23.0	9.5	.8
May 17–May 23	7.9	64.2	33.4	17.7	3.7
May 24–May 30	7.9	66.2	36.7	20.7	5.1
May 31–June 6	2.0	77.7	52.9	36.8	15.3
June 7–June 13	4.0	82.8	56.6	37.6	12.8
June 14–June 20	9.9	75.0	47.5	29.2	8.2
June 21–June 27	7.9	73.3	47.9	31.6	11.4
June 28–July 4	4.0	73.3	35.5	16.1	2.0
July 5–July 11	15.7	63.7	37.0	21.6	5.7
July 12–July 18	19.7	50.2	23.4	11.4	2.0
July 19–July 25	15.7	45.3	19.3	8.9	.9
July 26–August 1	13.8	55.9	28.8	15.6	3.6
August 2–August 8	11.8	58.2	26.1	11.8	1.6
August 9–August 15	23.6	52.4	28.7	16.3	4.2
August 16–August 22	23.6	50.5	27.8	16.1	4.4
August 23–August 29	27.5	41.1	17.0	7.4	.7
August 30–September 5	33.4	35.3	12.7	4.8	.4
September 6–September 12	17.7	47.9	16.1	5.4	.3
September 13–September 19	27.5	41.8	12.0	3.3	0
September 20–September 26	27.5	41.8	20.7	11.2	2.6

2-week period	Probability of receiving at least—				
	Trace or none	0.20 in.	0.60 in.	1.00 in.	2.00 in.
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*
March 29–April 11	9.9	62.0	21.7	6.9	0.3
April 12–April 25	2.0	72.0	38.7	20.8	4.4
April 26–May 9	2.0	78.1	48.7	30.2	9.1
May 10–May 23	2.0	88.0	59.8	37.3	9.9
May 24–June 6	2.0	92.2	75.6	59.6	30.5
June 7–June 20	2.0	95.3	82.6	67.1	34.4
June 21–July 4	0	92.1	71.8	53.8	24.3
July 5–July 18	2.0	82.8	56.5	38.0	13.8
July 19–August 1	2.2	77.9	48.7	30.3	9.2
August 2–August 15	2.0	82.9	54.6	34.9	10.8
August 16–August 29	4.0	69.4	42.8	27.5	9.6
August 30–September 12	4.0	67.0	32.9	16.2	2.8
September 13–September 26	9.9	66.1	36.8	20.6	4.9

3-week period	Probability of receiving at least—				
	Trace or none	0.20 in.	0.60 in.	1.00 in.	2.00 in.
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*
March 22–April 11	2.0	76.5	41.6	21.7	4.0
April 12–May 2	2.0	88.4	62.9	42.1	13.8
May 3–May 23	2.0	94.9	77.5	56.8	20.7
May 24–June 13	0	98.8	92.0	82.0	55.0
June 14–July 4	0	99.3	92.4	80.7	47.6
July 5–July 25	2.0	90.1	69.6	51.6	22.6
July 26–August 15	0	93.9	74.4	55.5	23.6
August 16–September 5	0	80.6	54.4	37.0	14.4
September 6–September 26	4.4	83.8	55.7	35.0	9.9

TABLE 10.—*Probability of last damaging cold temperature in spring and first in fall*

Probability	Date for given probability and temperature—				
	16° F. or lower	20° F. or lower	24° F. or lower	28° F. or lower	32° F. or lower
Spring:					
10 percent of the years later than	April 28	May 4	May 14	May 22	June 3
25 percent of the years later than	April 20	May 1	May 8	May 15	May 27
50 percent of the years later than	April 11	April 22	April 30	May 8	May 20
75 percent of the years later than	April 1	April 14	April 22	May 1	May 13
90 percent of the years later than	March 24	April 6	April 14	April 24	May 6
Fall:					
10 percent of the years earlier than	October 14	October 3	September 22	September 15	September 7
25 percent of the years earlier than	October 22	October 11	October 1	September 21	September 13
50 percent of the years earlier than	October 30	October 20	October 8	September 28	September 19
75 percent of the years earlier than	November 9	October 29	October 16	October 5	September 25
90 percent of the years earlier than	November 17	November 6	October 24	October 11	October 1

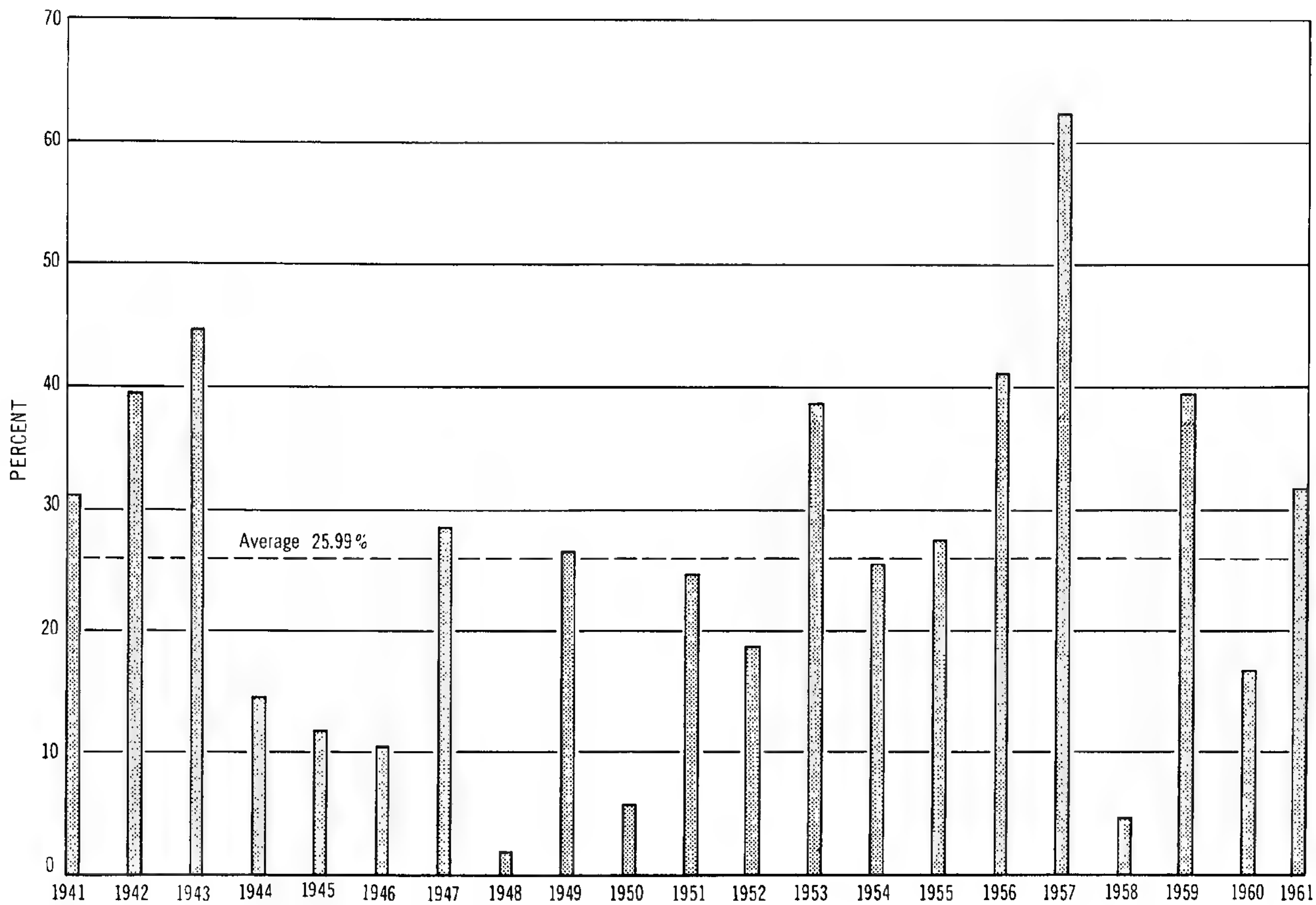

Figure 20.—**Percentage of insured acreage on which crops were damaged during the period 1941–61.**

TABLE 11.—*Average monthly and annual hours of wind, by velocity groups (miles per hour), during the period 1936–38.*

[From records at Dickinson, N. Dak.]

Month	Velocity group (miles per hour)				
	4–15	16–31	32–47	Calm [1]	Total
January	367	288	17	48	720
February	344	210	18	73	645
March	438	205	35	66	744
April	429	227	26	38	720
May	388	282	44	30	744
June	438	231	17	34	720
July	529	141	3	71	744
August	470	190	3	81	744
September	464	198	5	53	720
October	428	253	5	58	744
November	415	258	14	33	720
December	398	281	21	44	744
Total	5, 108	2, 764	208	629	8, 709
Percent	59	32	2	7	100

[1] Less than 4 miles per hour.

ranchers mix tame and native hay with ensilage and grain supplements for their feeder and breeding herds. During years of normal or above-normal rainfall, two cuttings of tame hay are harvested. The tame hay consists mainly of alfalfa, alfalfa-tame grass mixtures, or tame grasses alone. Native hay is usually cut only once every 2 years, unless the areas where it grows receive additional moisture from runoff, a high water table, or water spreading. Where enough moisture is available that the crop grows well, the hay is cut once each year.

Flax, rye, and safflower are grown on a small acreage each year. Safflower is a comparatively new crop in this county and is grown under contract. The processing of this crop for oil is done outside the State.

Livestock.—Cattle are raised on approximately 80 percent of the farms or ranches, in the county. A total of 47,417 head of cattle and calves, including 7,478 milk cows were in the county in 1959. Most of the beef cattle are Herefords, but Aberdeen Angus cattle and Shorthorns make up some herds. The bulls are generally purebreds, and the cows are good grade stock. The herds graze from 7 to 9 months each year, depending on the type of winter and condition of the pastures. The cattle are then kept in feedlots or holding pastures for the rest of the year. The calving period is mainly in April. Selling weaner calves in fall is a common practice, but many ranchers feed steers and heifers until they reach market weight. Milk that is sold for bottling is produced on several large dairy farms near Dickinson. Cream for making butter, and milk for making cheese, are produced at several smaller dairy farms.

A few ranchers raise sheep as their main agricultural enterprise. In 1959, 13,690 sheep and lambs were in the county. On the sheep ranches, a breeding herd of several hundred ewes is maintained. Lambs are sold in fall, and wool is sold early in spring. On some farms where cattle are the main source of income, sheep or hogs are raised as a secondary enterprise. In 1959, 12,880 hogs and pigs were in the county.

Most of the horses in the county are saddle horses. They are used on the cattle ranches or for recreation.

Irrigation

The two main requirements for a profitable irrigation project are good soils and available salt-free water. Many of the soils in this county are well suited to irrigation, because they take in water well, are deep, and have favorable relief. Chief among these are the Straw, Havre, Glendive, Manning, Parshall, and Farland. Unfortunately, however, there is only a limited supply of water suitable for irrigation. There are no known underground sources large enough to warrant irrigation from deep wells.

By 1963, approximately 200 acres had been leveled for gravity-type irrigation. This acreage is along the Heart and Green Rivers (fig. 21), and it depends upon normal

Figure 21.—**An irrigated field of alfalfa and bromegrass along the Heart River. Havre loam is the main soil in this field.**

streamflow for a supply of water. Controlled releases of water from the Dickinson Reservoir provide a dependable supply of water for the areas along the Heart River. If an irrigation project is planned, water rights must be obtained from the State Water Conservation Commission at Bismarck.

Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster, such as a clod, crumb, block, or prism.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Badlands. Areas of rough, irregular land where most of the surface is occupied by ridges, gullies, and deep channels.

Bedded shale. Layered, soft sedimentary rock that is undisturbed and unweathered. Examples of this kind of rock are *clayey shale*, which contains more than 40 percent clay, and *silty shale*, which contains more than 50 percent silt.

Blowout. An area from which soil material has been removed by wind.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. (Called also limy soil.)

Catena. A sequence, or "chain," of soils on a landscape, developed from one kind of parent material but having different characteristics because of differences in relief and drainage.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt. (See also Texture, soil.)

Claypan. A compact, slowly permeable soil horizon that contains more clay than the horizon above and below it. A claypan is commonly hard when dry and plastic or stiff when wet.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent; will not hold together in a mass.

Friable.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Forb. Any herbaceous plant, neither a grass or sedge, that is grazed on western ranges.

Genesis, soil. The manner in which a soil originated, with special reference to the processes responsible for the development of the solum, or true soil, from the unconsolidated parent material.

Hardpan. A hardened or cemented soil horizon, or layer. The material may be sandy or clayey, and it may be cemented by iron oxide, silica, calcium carbonate, or other susbtance.

Horizon, soil. A layer of soil, approximately parallel to the surface that has distinct characteristics produced by soil-forming processes.

Internal soil drainage. The downward movement of water through the soil profile. The rate of movement is determined by the texture, structure, and other characteristics of the soil profile and underlying layers, and by the height of the water table, either permanent or perched. Relative terms for expressing internal drainage are *none, very slow, slow, medium, rapid,* and *very rapid.*

Loam. Soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. (See also Texture, soil.)

Loamy. Used to describe soils that have a texture of silt loam, loam, or clay loam.

Microrelief. Minor surface configurations of the land.

Mottled. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent.* The size measurements are these: *Fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Natural drainage. Refers to the conditions that existed during the development of the soil as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of a channel or the blocking of a drainage outlet. Seven different classes of natural drainage are recognized. These are *excessively drained, somewhat excessively drained, well drained, moderately well drained, imperfectly* or *somewhat poorly drained, poorly drained,* and *very poorly drained.*

Parent material. The unconsolidated mass from which the soil profile develops.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability, soil. The quality of a soil horizon that enables water or air to move through it. Terms used to describe permeability are *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

pH value. A numerical means for designating relatively weak acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value indicates alkalinity; and a lower value indicates acidity. (See also Reaction, soil.)

Pitting, contour. Making shallow pits or basins of suitable capacity and distribution on the contour in areas of range, to retain water from rainfall and snowmelt.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus (*15*):

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.0 and higher

Rill erosion. A steep-sided channel resulting from accelerated erosion. A rill normally is a few inches in depth and width and is not large enough to be an obstacle to farm machinery.

Saline-alkali soil. A soil having a combination of a harmful quantity of salts and either a high degree of alkalinity or a large amount of exchangeable sodium, or both, so distributed in the profile that the growth of most crop plants is less than normal.

Saline soil. A soil that contains soluble salts in an amount large enough to impair the growth of plants but that does not contain excess exchangeable sodium.

Sand. Individual rock or mineral fragments in soil having a diameter ranging from 0.05 millimeter to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay. (See also Texture, soil.)

Sheet erosion. The removal of a fairly uniform layer of soil or material from the land surface by the action of rainfall and runoff water.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil material of the silt textural class is 80 percent or more silt and less than 12 percent clay. (See also Texture, soil.)

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in a mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are *platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular.* Structureless soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the profile below plow depth.

Substratum. Any layer lying beneath the solum, or true soil; the C or R horizon.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportions of fine particles are as follows: Sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine." (See also Clay, Sand, and Silt.)

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

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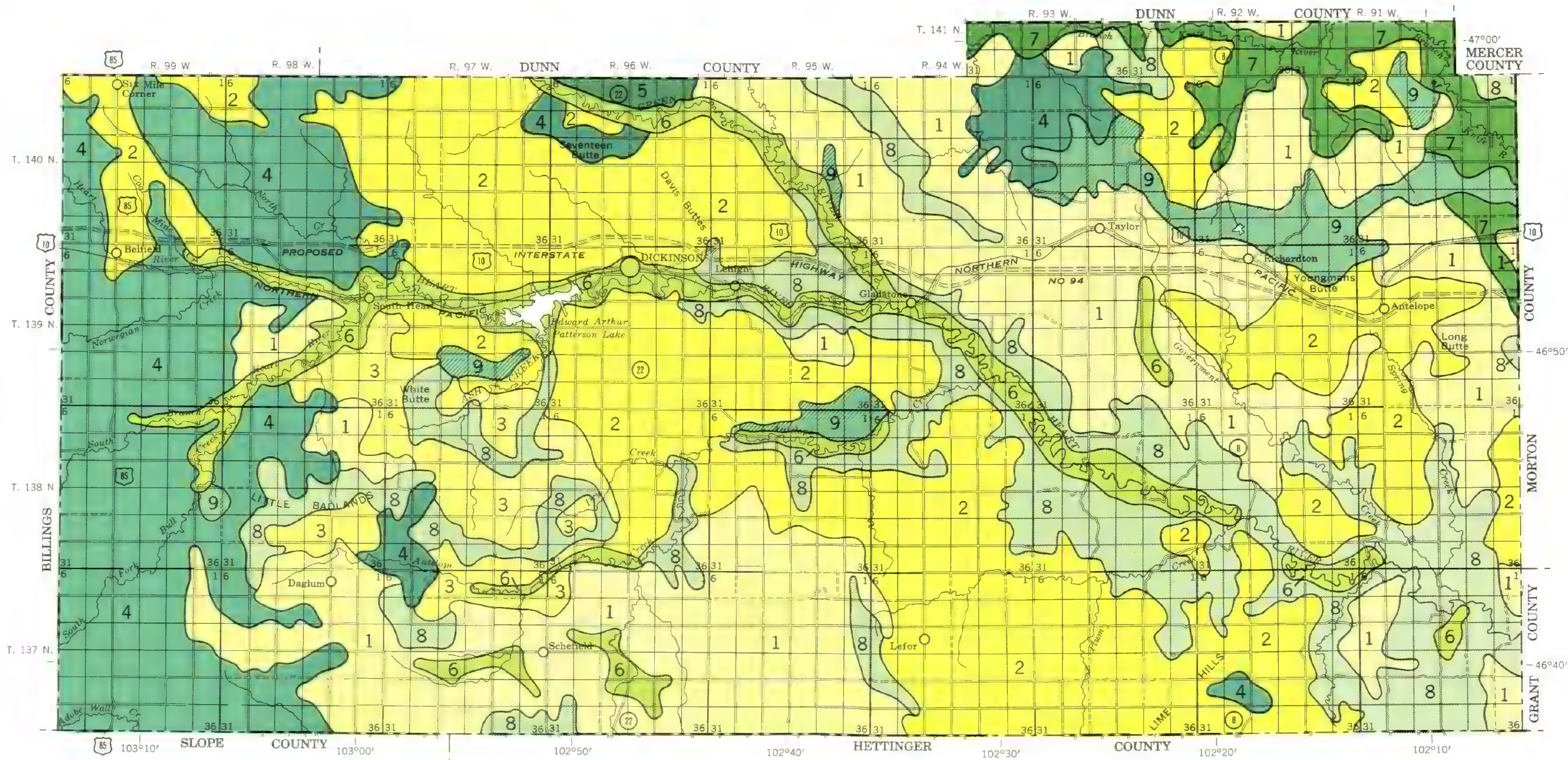


SOIL ASSOCIATIONS

DEEP OR MODERATELY DEEP, NEARLY LEVEL TO SLOPING SOILS OF THE UPLANDS

1 Morton-Regent-Grail association: Deep, well-drained, silty or clayey soils

2 Morton-Vebar-Arnegard association: Deep, well-drained, loamy and moderately sandy soils

3 Promise-Moreau association: Deep or moderately deep, well-drained, clayey soils

DEEP TO SHALLOW, NEARLY LEVEL TO MODERATELY SLOPING SOILS OF THE UPLANDS THAT HAVE A CLAYPAN AND ACCUMULATED SALTS

4 Rhoades-Promise-Moreau association: Deep to shallow, well-drained, loamy or clayey soils

5 Belfield-Rhoades association: Deep, well-drained, loamy soils

DEEP, NEARLY LEVEL SOILS ON STREAM TERRACES AND BOTTOM LANDS

6 Farland-Havre-Parshall association: Deep, well drained or moderately well drained, moderately sandy or loamy soils

7 Farland-Savage-Rhoades association: Deep, well drained or moderately well drained, loamy or clayey soils, some of which have a claypan

SHALLOW, STEEP OR STRONGLY SLOPING SOILS OF THE UPLANDS

8 Bainville-Midway association: Shallow, excessively drained, loamy or clayey soils

9 Bainville-Flasher association: Shallow, excessively drained, loamy or moderately sandy soils

February 1966

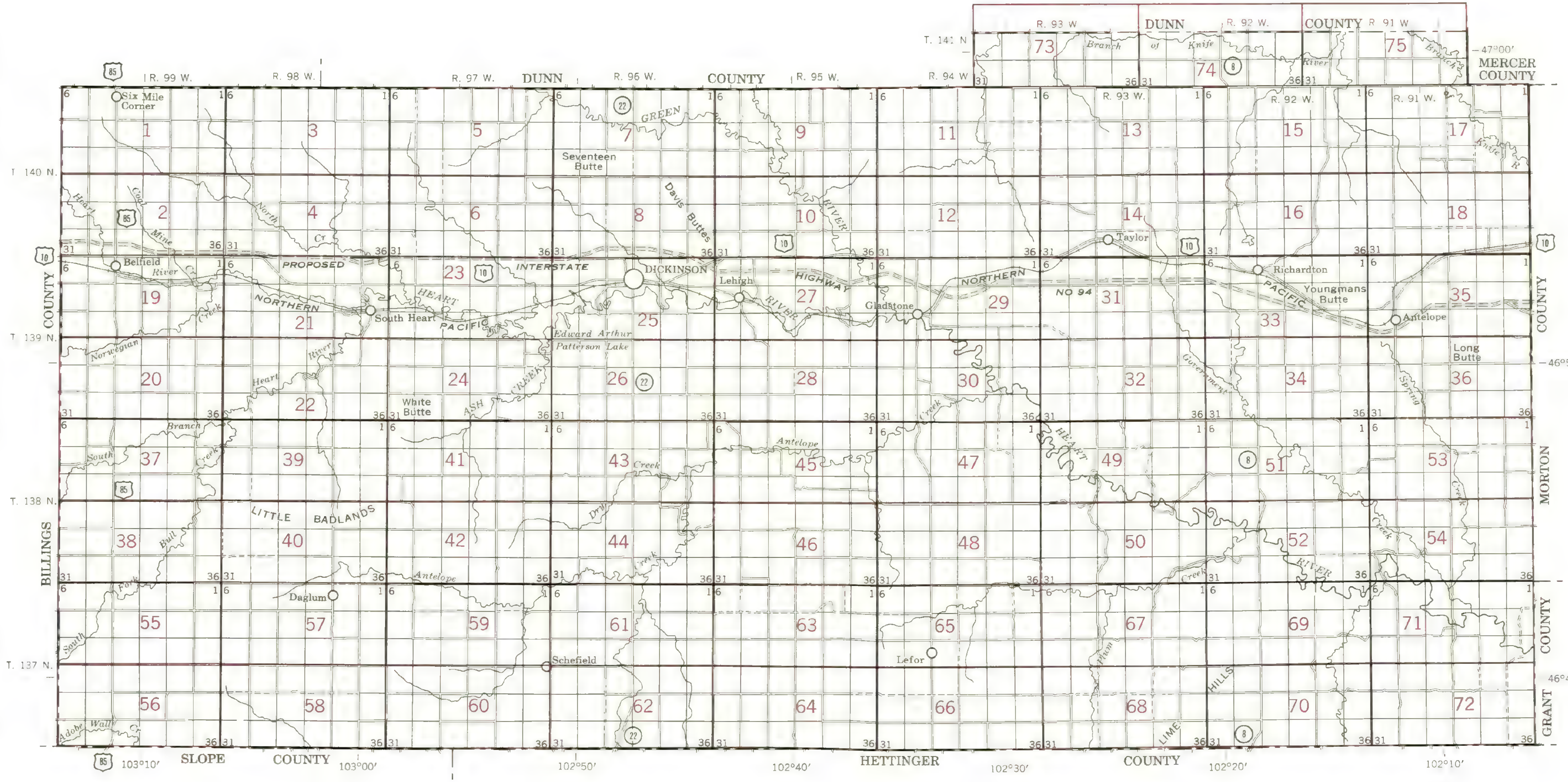
N

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP
STARK COUNTY, NORTH DAKOTA

Scale 1:253,440

1 0 1 2 3 4 Miles



INDEX TO MAP SHEETS

STARK COUNTY, NORTH DAKOTA

Scale 1:253,440

1 0 1 2 3 4 Miles

SOIL LEGEND

The first capital letter is the initial one of the soil name. A second capital letter, A, B, C, D, or E shows the slope. Most symbols without a slope letter are for nearly level soils, but some are for soils or land types that have a wide range of slope. A final number, 2, in the symbol shows that the soil is eroded.

SYMBOL	NAME
ArA	Arnegard loam, level
ArB	Arnegard loam, gently sloping
BaB	Bainville and Midway soils, undulating
BaC	Bainville and Midway soils, steep
Bd	Bainville and Midway stony soils
BeD	Bainville–Rhoades complex, strongly sloping
Bf	Bainville–Shale outcrop complex
Bg	Banks and Glendive soils
Bk	Beckton complex
BoA	Belfield–Rhoades loams, level
BoB	Belfield–Rhoades loams, gently sloping
BrA	Belfield–Rhoades silty clay loams, level
BrB	Belfield–Rhoades silty clay loams, gently sloping
ChC	Chama–Bainville loams, sloping
ChD	Chama–Bainville loams, strongly sloping
CnB	Cherry silty clay loam, gently sloping
CnC	Cherry silty clay loam, sloping
Co	Colvin silt loam
Dk	Dimmick clay
Es	Eroded sandy land
FaB	Farland silt loam, gently sloping
FaC	Farland silt loam, sloping
FgA	Farland, Arnegard and Grail silt loams, level
FlC	Flasher sandy loam, sloping
Fm	Flasher complex
Fr	Flasher–Rock outcrop complex
Ga	Gallatin clay loam
Gf	Glendive fine sandy loam
GrA	Grail silty clay loam, level
GrB	Grail silty clay loam, gently sloping
GrC	Grail silty clay loam, sloping
Gs	Grail soils, saline
GtA	Grail–Rhoades silty clay loams, level
GtB	Grail–Rhoades silty clay loams, gently sloping
Gv	Gravelly land
Ha	Havre loam
He	Havre silty clay loam
Hv	Hoven soils
LeB	Lefor fine sandy loam, undulating
LeB2	Lefor fine sandy loam, undulating, eroded
LeC	Lefor fine sandy loam, sloping
LeC2	Lefor fine sandy loam, sloping, eroded
LrB	Lihen loamy fine sand, undulating
LlC	Lihen–Flasher loamy fine sands, rolling
LnA	Little Horn and Duncom soils, level
LnB	Little Horn and Duncom soils, gently sloping
MaA	Manning loam, level
McA	Manning fine sandy loam, level
McB	Manning fine sandy loam, gently sloping
McC	Manning fine sandy loam, sloping
Md	Mine dumps
MeA	Moreau silty clay, level
MeB	Moreau silty clay, gently sloping
MeC	Moreau silty clay, sloping
Mf	Moreau stony soils
MgD	Moreau–Midway silty clays, strongly sloping
Mh	Moreau–Midway–Rock outcrop complex
Mk	Moreau–Rock outcrop complex
Mm	Morton stony loam
MnD	Morton–Bainville complex, strongly sloping
MoC	Morton–Chama clay loams, sloping
MpC	Morton–Chama silt loams, sloping
MpC2	Morton–Chama silt loams, sloping, eroded
MrA	Morton and Farland clay loams, level
MrB	Morton and Farland clay loams, gently sloping
MsA	Morton and Farland silt loams, level
MsB	Morton and Farland silt loams, gently sloping
MtA	Morton–Rhoades loams, level
MtB	Morton–Rhoades loams, gently sloping
MtC	Morton–Rhoades loams, sloping
MtC2	Morton–Rhoades loams, sloping, eroded
PaA	Parshall fine sandy loam, level
PrA	Promise silty clay, level
PrB	Promise silty clay, gently sloping
ReA	Regent silty clay loam, level
ReB	Regent silty clay loam, gently sloping
RgA	Regent–Moreau silty clay loams, level
RgB	Regent–Moreau silty clay loams, gently sloping
RgC	Regent–Moreau silty clay loams, sloping
RsA	Rhoades and Belfield soils, level
RsB	Rhoades and Belfield soils, gently sloping
Sa	Saline alluvial land
Sg	Savage silty clay loam
ShA	Savage–Rhoades silty clay loams, level
Sm	Searing loam
So	Shale outcrop–Bainville complex
Sp	Shale outcrop
StA	Straw loam, level
Sv	Straw and Havre soils, channeled
VaE	Valentine fine sand, hilly
VfD	Vebar–Flasher fine sandy loams, strongly sloping
VmC	Vebar–Manning fine sandy loams, sloping
VpB	Vebar–Parshall fine sandy loams, undulating
VpC	Vebar–Parshall fine sandy loams, sloping
Wa	Wet alluvial land
Wb	Wibaux soils

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads
- Dual
- Good motor
- Poor motor
- Trail

Highway markers
- National Interstate
- U. S.
- State

Railroads
- Single track
- Multiple track
- Abandoned

Bridges and crossings
- Road
- Trail, foot
- Railroad
- Ferries
- Ford
- Grade
- R. R. over
- R. R. under
- Tunnel

Buildings
- School
- Church
- Station

Mines and Quarries
Mine dump
Pits, gravel or other
Power lines
Pipe lines
Cemeteries
Dams
Levees
Tanks
Windmills

BOUNDARIES

- National or state
- County
- Township, U. S.
- Section line, corner
- Reservation
- Land grant

DRAINAGE

Streams
- Perennial
- Intermittent, unclass.

Canals and ditches — CANAL / DITCH

Lakes and ponds
- Perennial
- Intermittent

Wells — flowing
Springs
Marsh
Wet spot
Alluvial fan
Drainage ends

RELIEF

Escarpments
- Bedrock
- Other

Prominent peaks
Depressions, unclassified

SOIL SURVEY DATA

Soil boundary and symbol — Dx
Gravel
Stones
Rock outcrops
Chert fragments
Clay spot
Sand spot
Gumbo or scabby spot
Made land
Severely eroded spot
Blowout, wind erosion
Gullies
Areas of alkali and salts — A

Soil map constructed 1965 by Cartographic Division, Soil Conservation Service, USDA, from 1957 aerial photographs. Controlled mosaic based on North Dakota plane coordinate system, south zone, Lambert conformal conic projection, 1927 North American datum.

STARK COUNTY, NORTH DAKOTA — SHEET NUMBER 1

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the North Dakota Agricultural Experiment Station. Range, township, and section corners shown on this map are indefinite.

Scale 1:20 000

1 Mile ½ 0

5000 Feet 0

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

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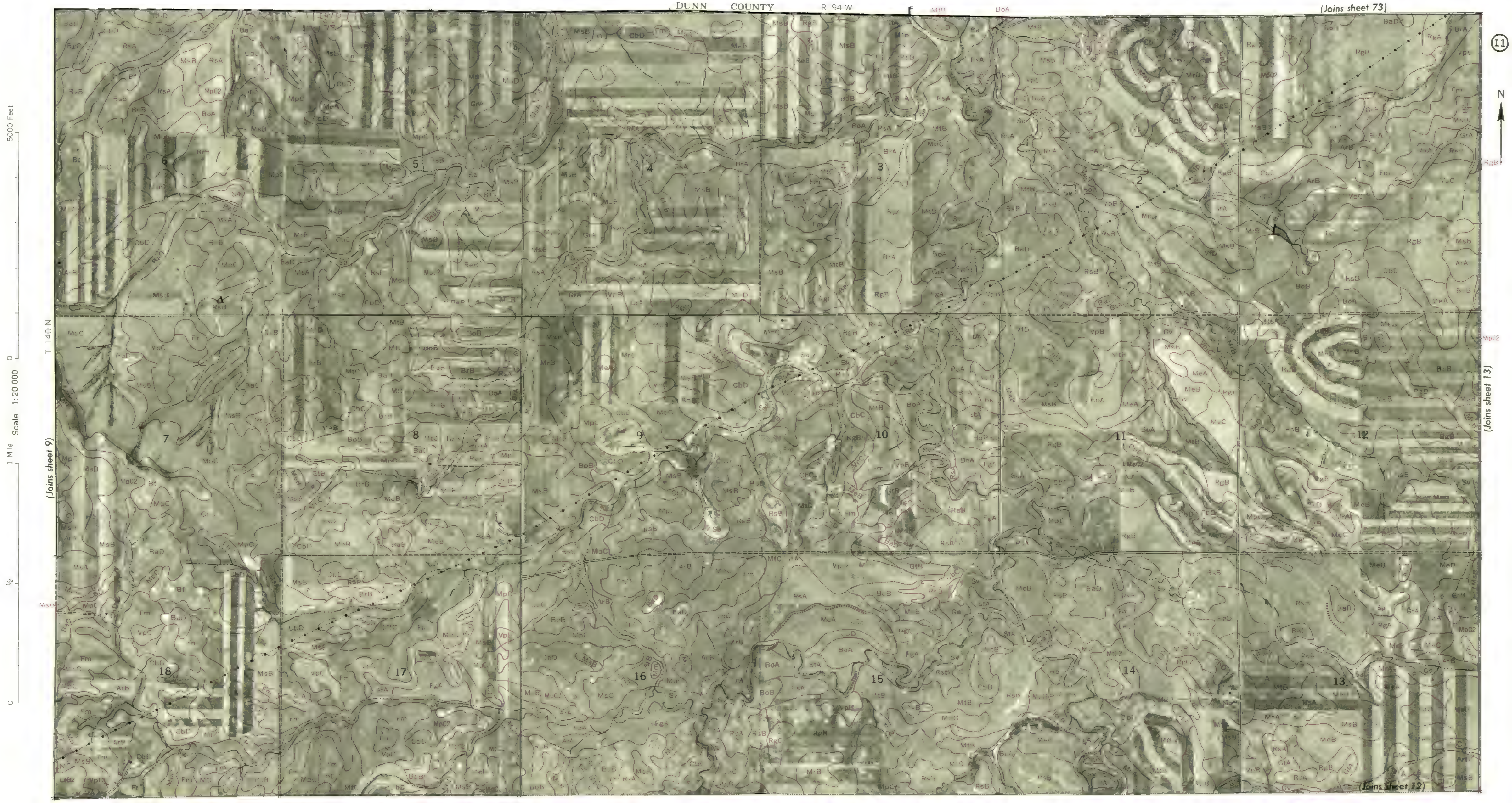

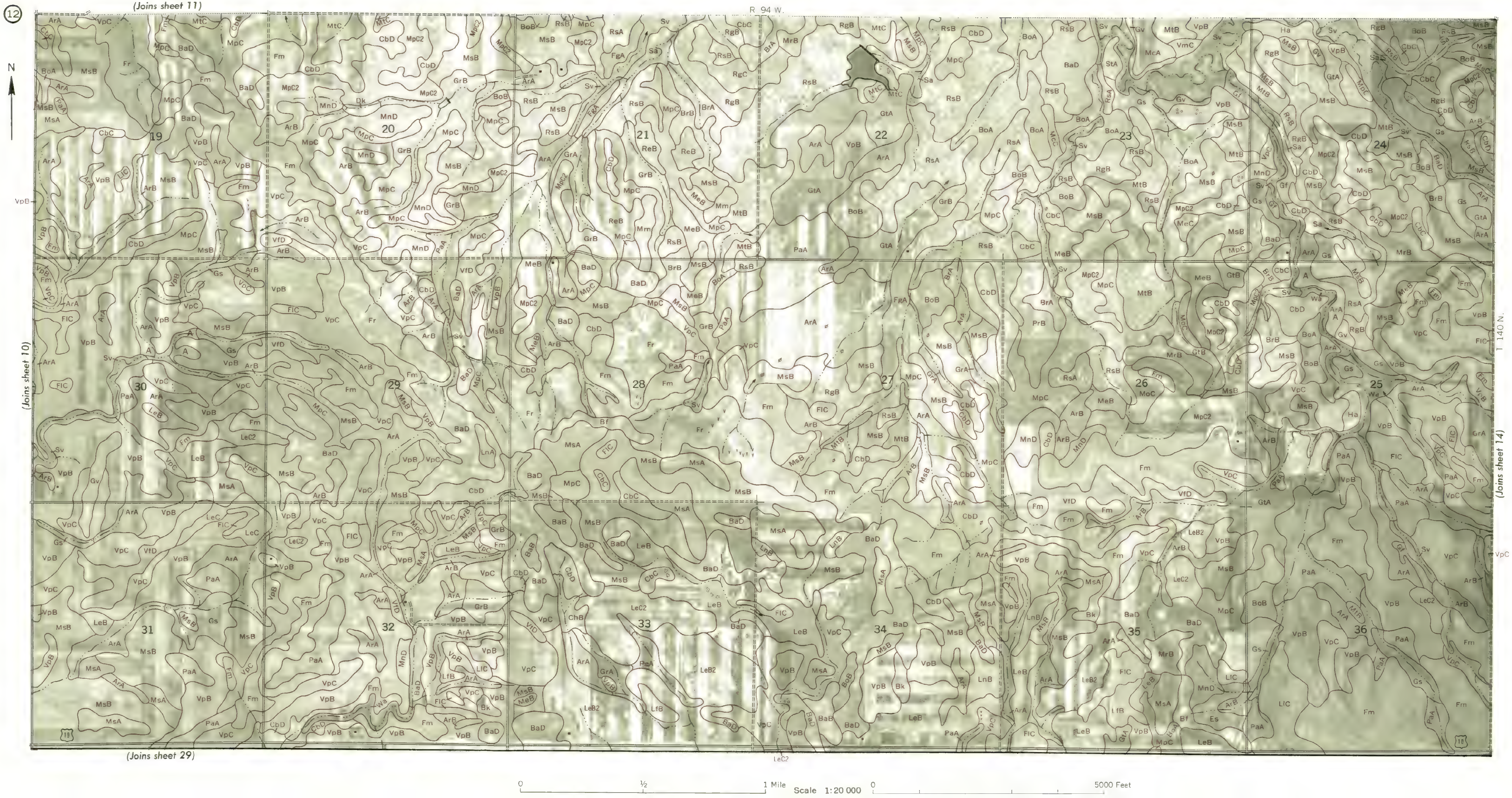

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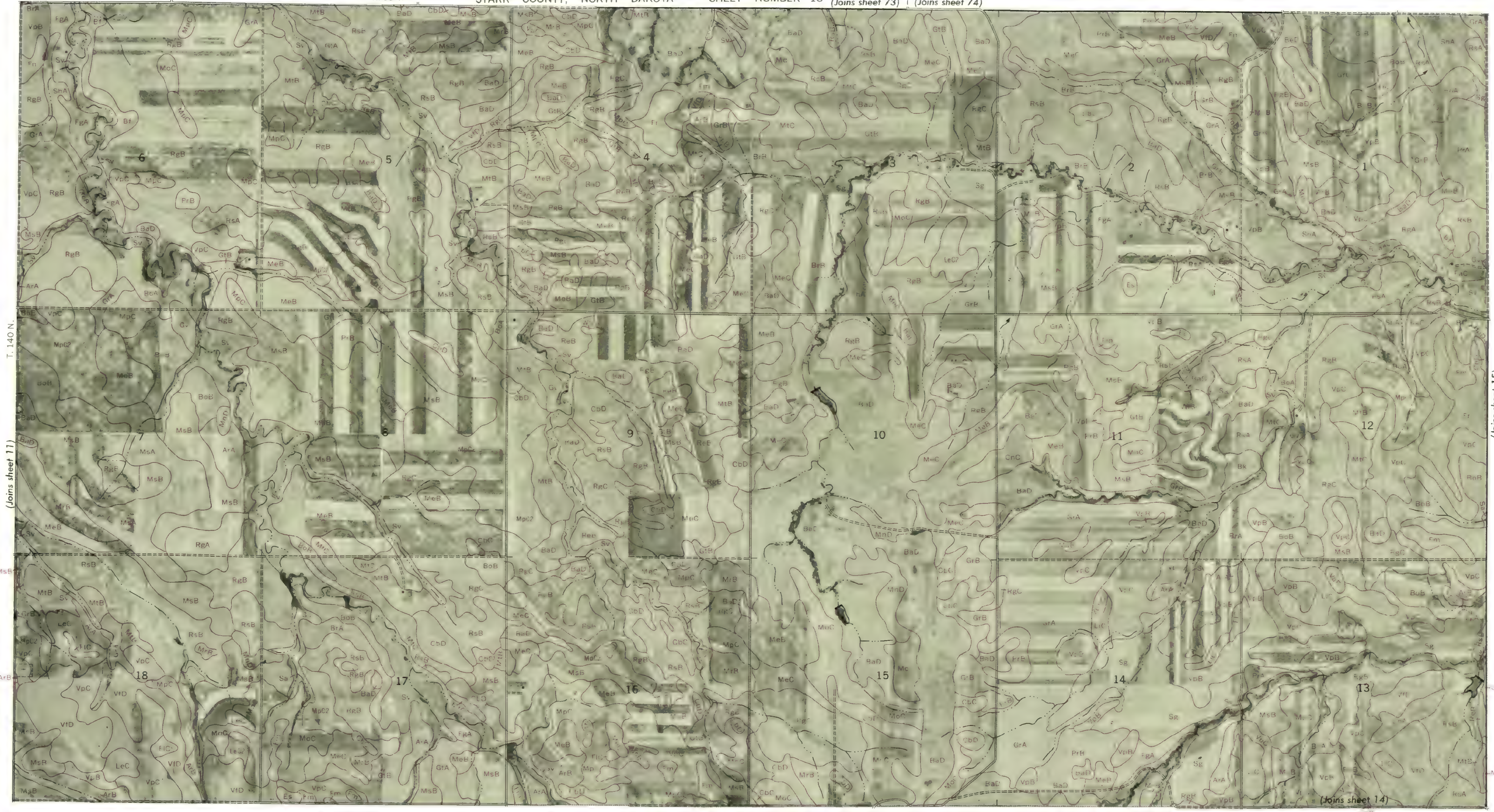
R. 93 W.

STARK COUNTY, NORTH DAKOTA — SHEET NUMBER 13 (Joins sheet 73) (Joins sheet 74)

13



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Scale 1:20 000

1 Mile

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T. 140 N.

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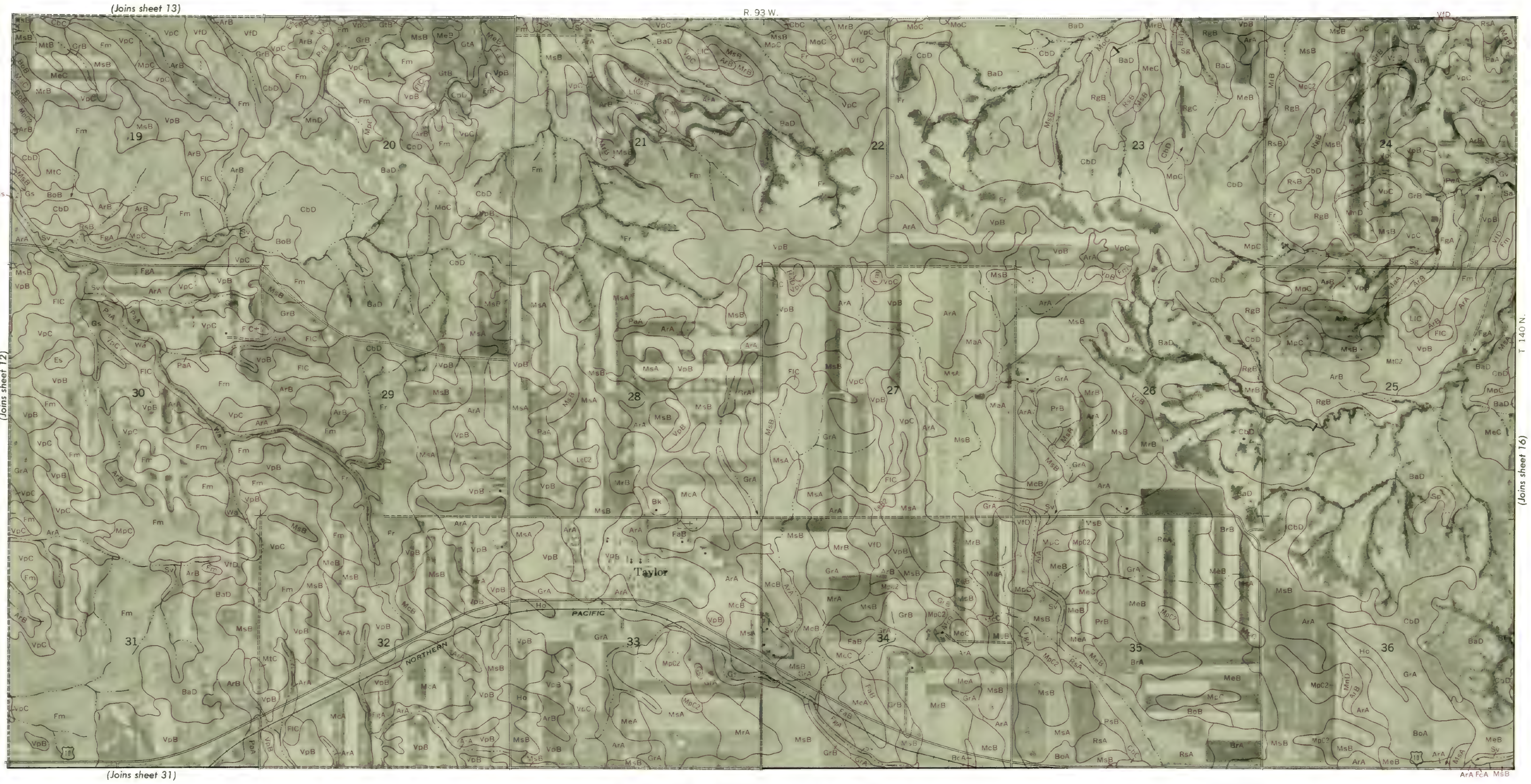
14



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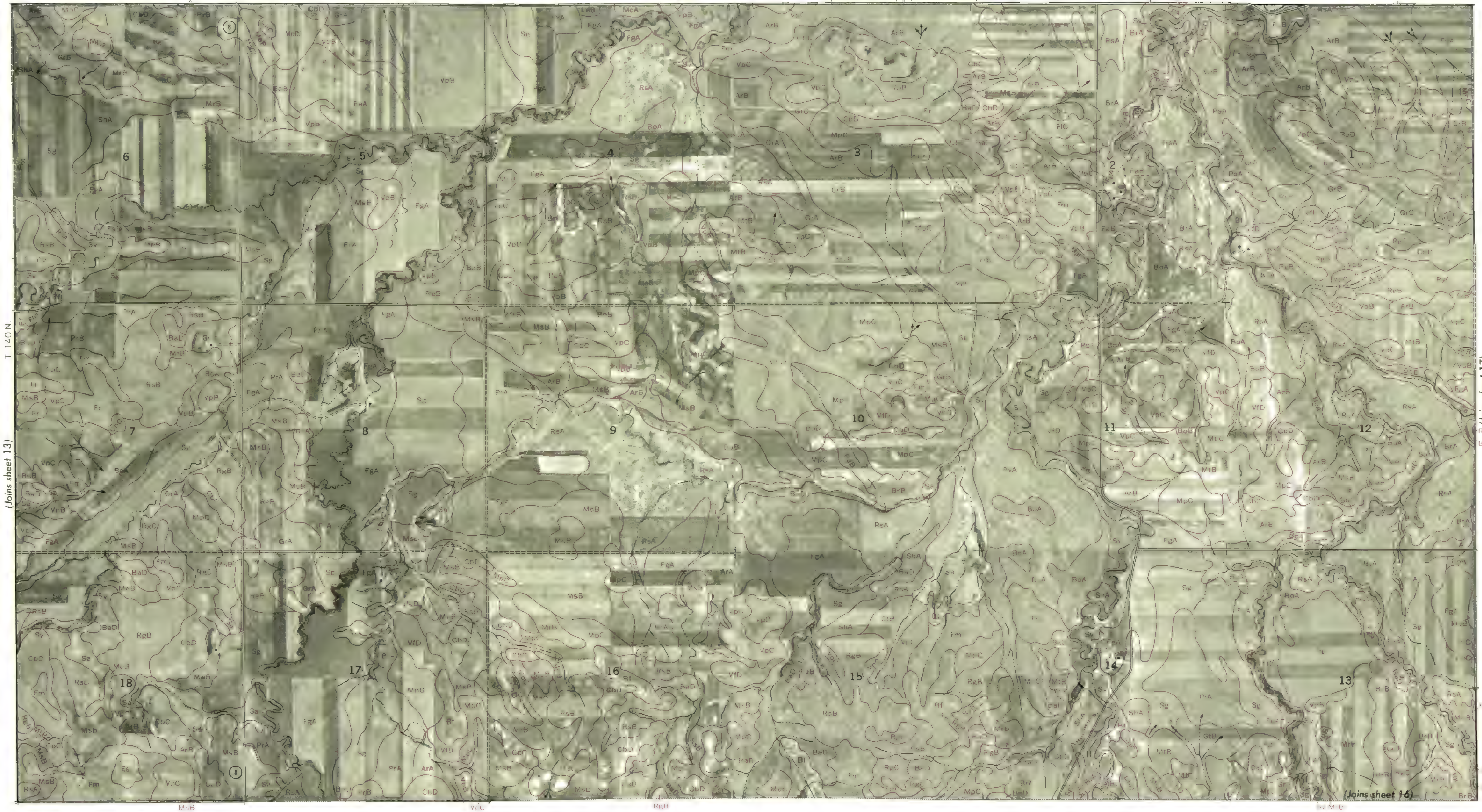
STARK COUNTY, NORTH DAKOTA — SHEET NUMBER 15



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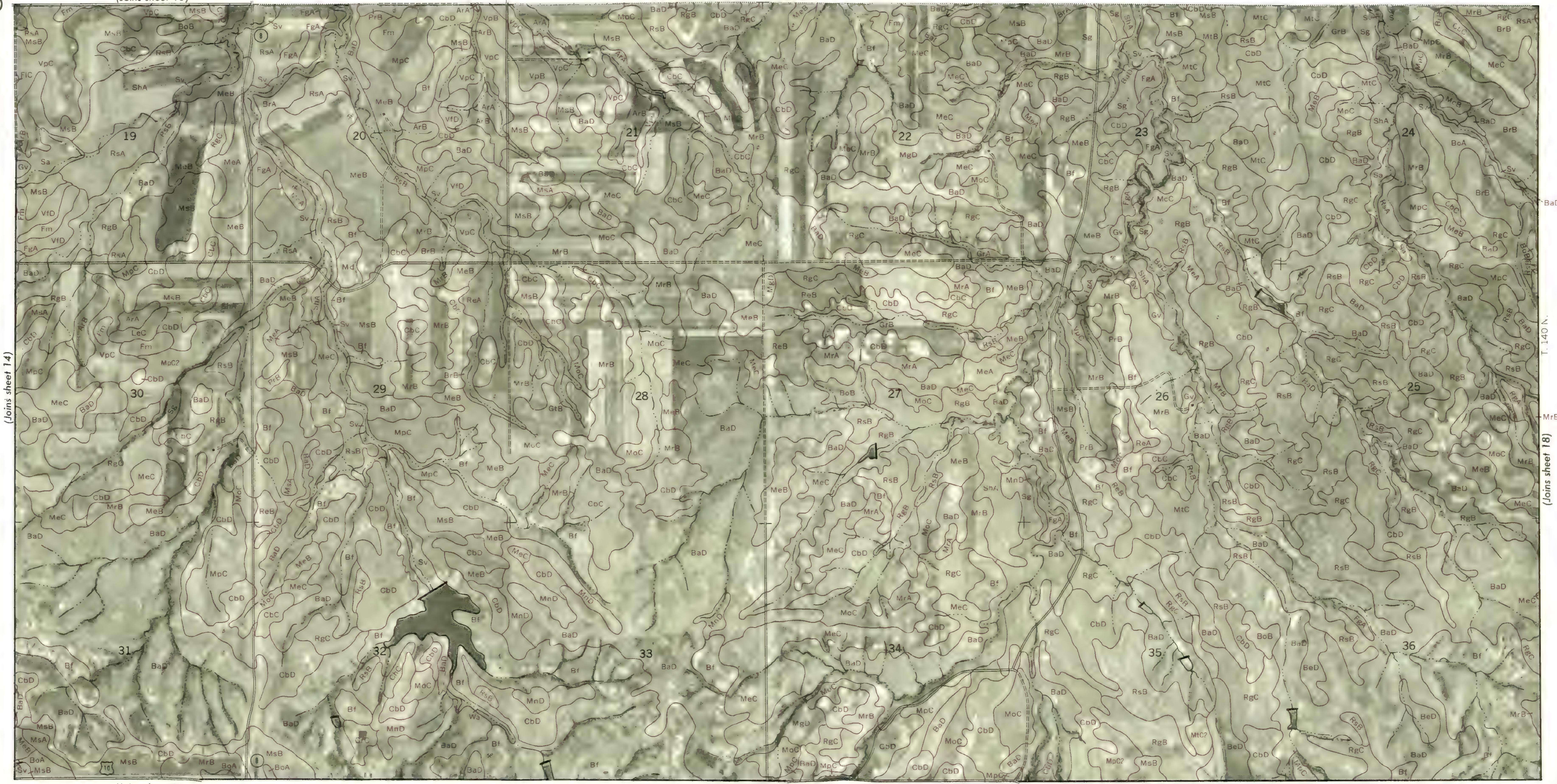
16

(Joins sheet 15)

R. 92 W.



(Joins sheet 14)

T. 140 N.

(Joins sheet 18)

(Joins sheet 33)

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

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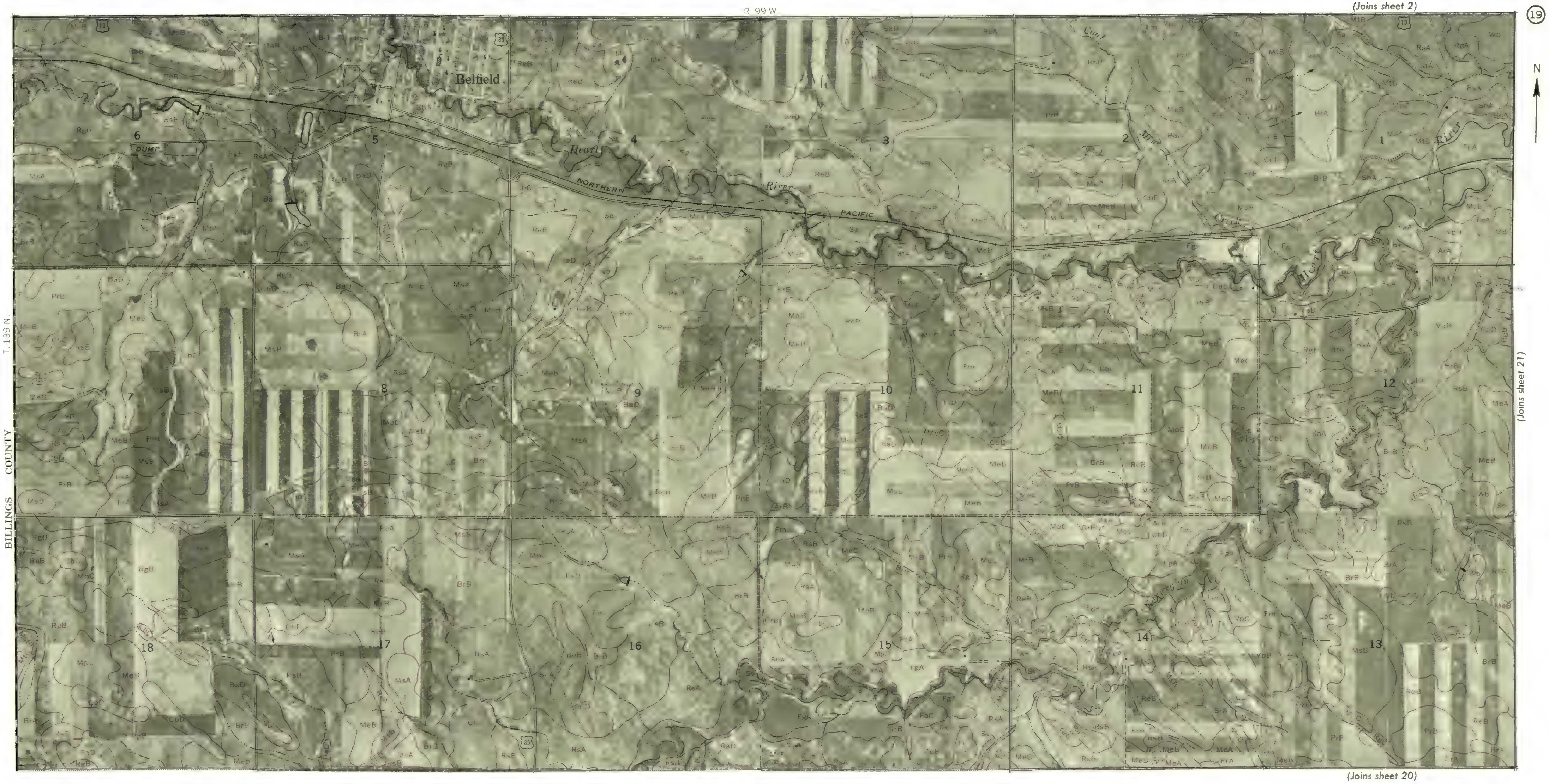
Scale 1: 20 000

1 Mile ½ 0

0 5000 Feet

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet



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0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

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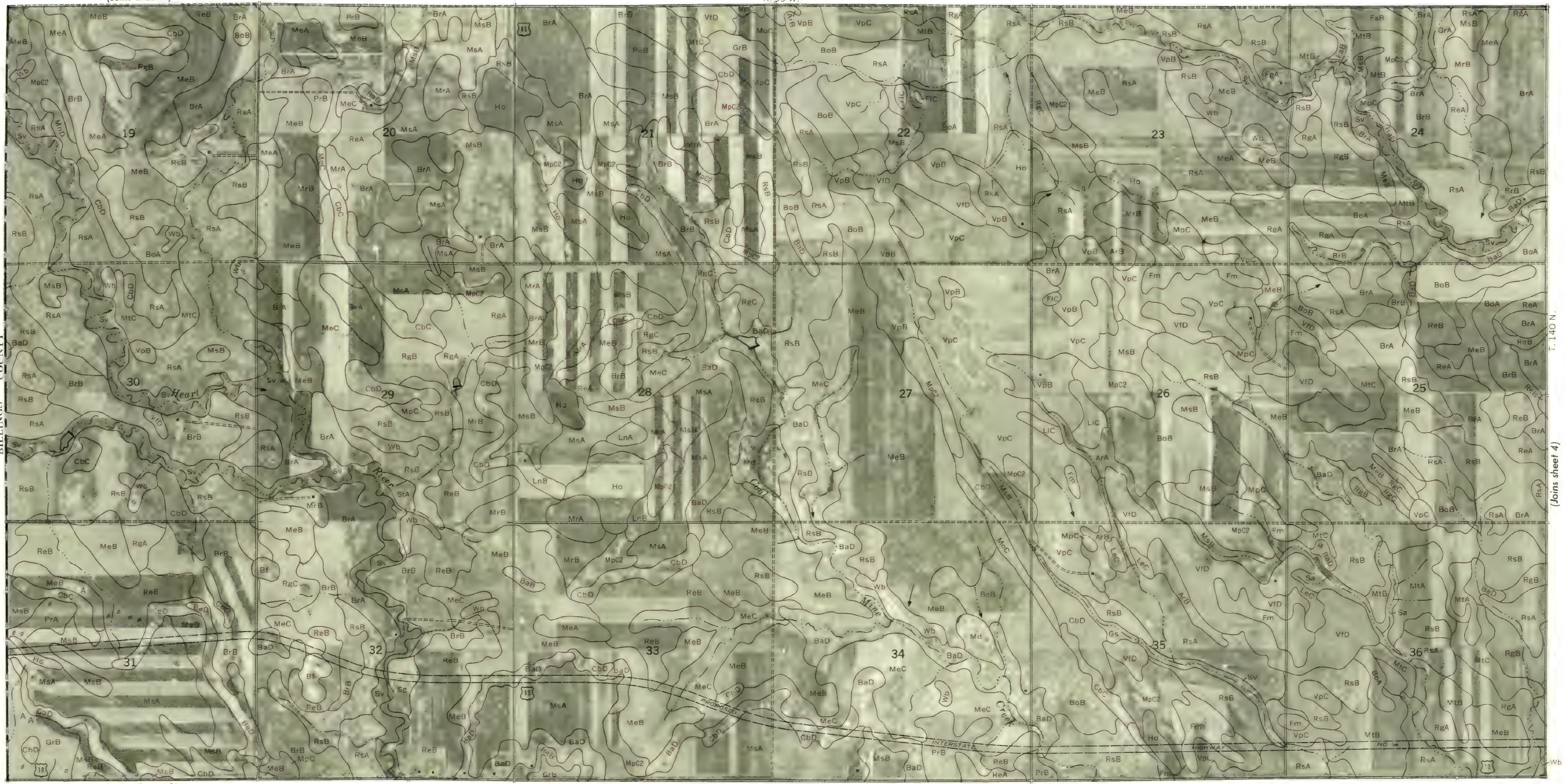
(Joins sheet 1)



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0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

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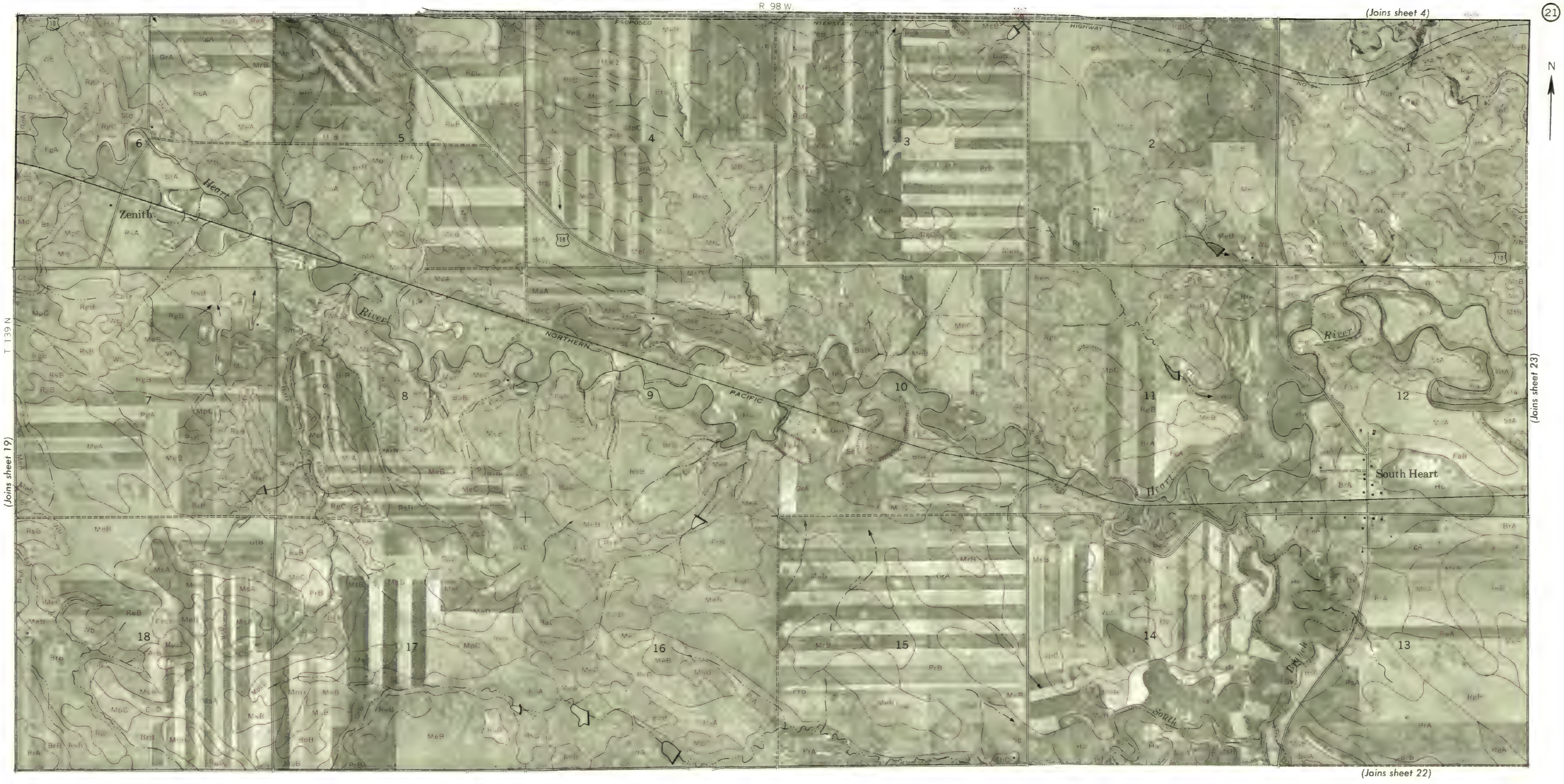

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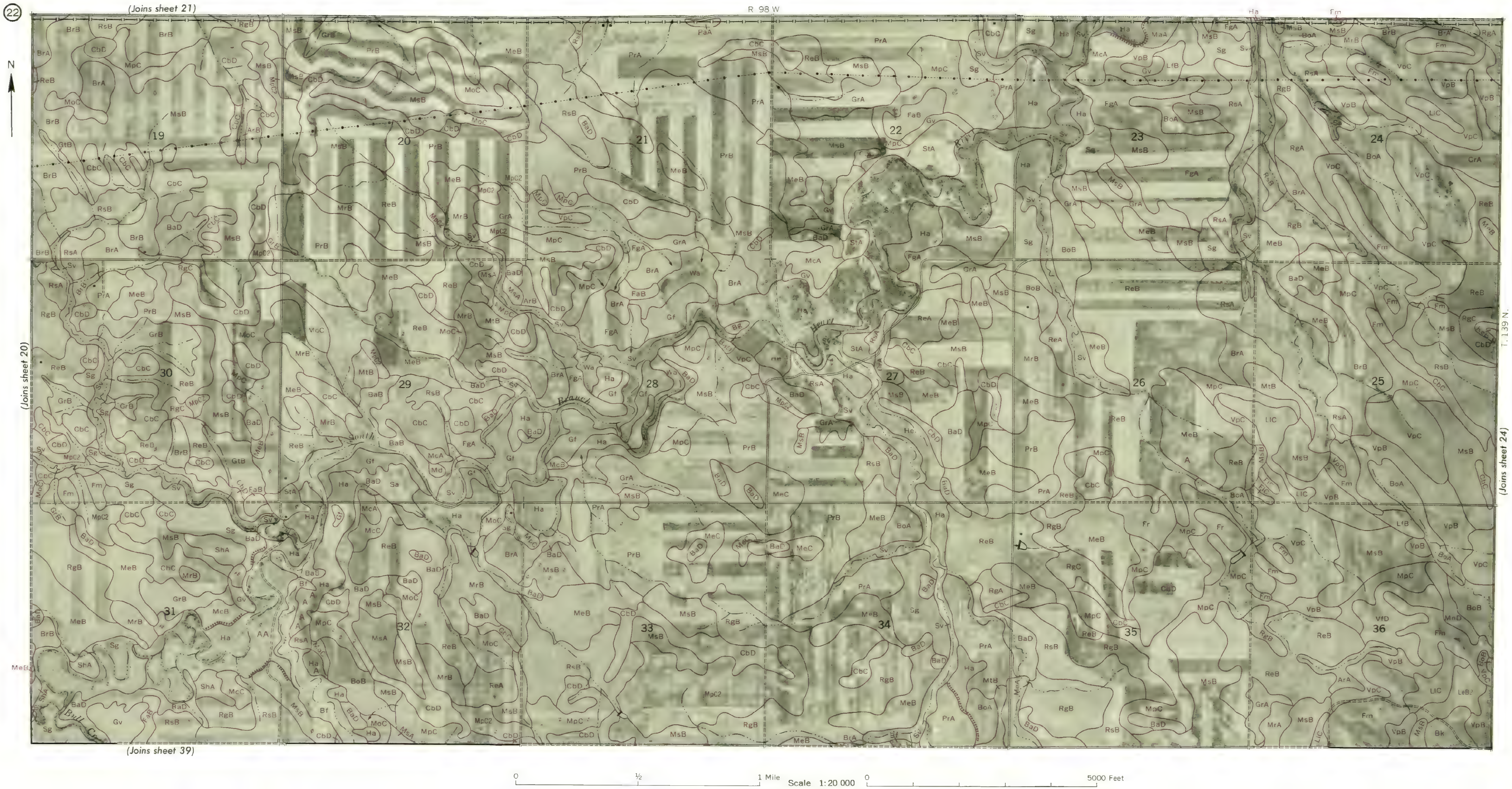
22
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R. 98 W.
N
T. 139 N.
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(Joins sheet 39)
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½
1 Mile
Scale 1: 20 000
0
5000 Feet

23

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0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

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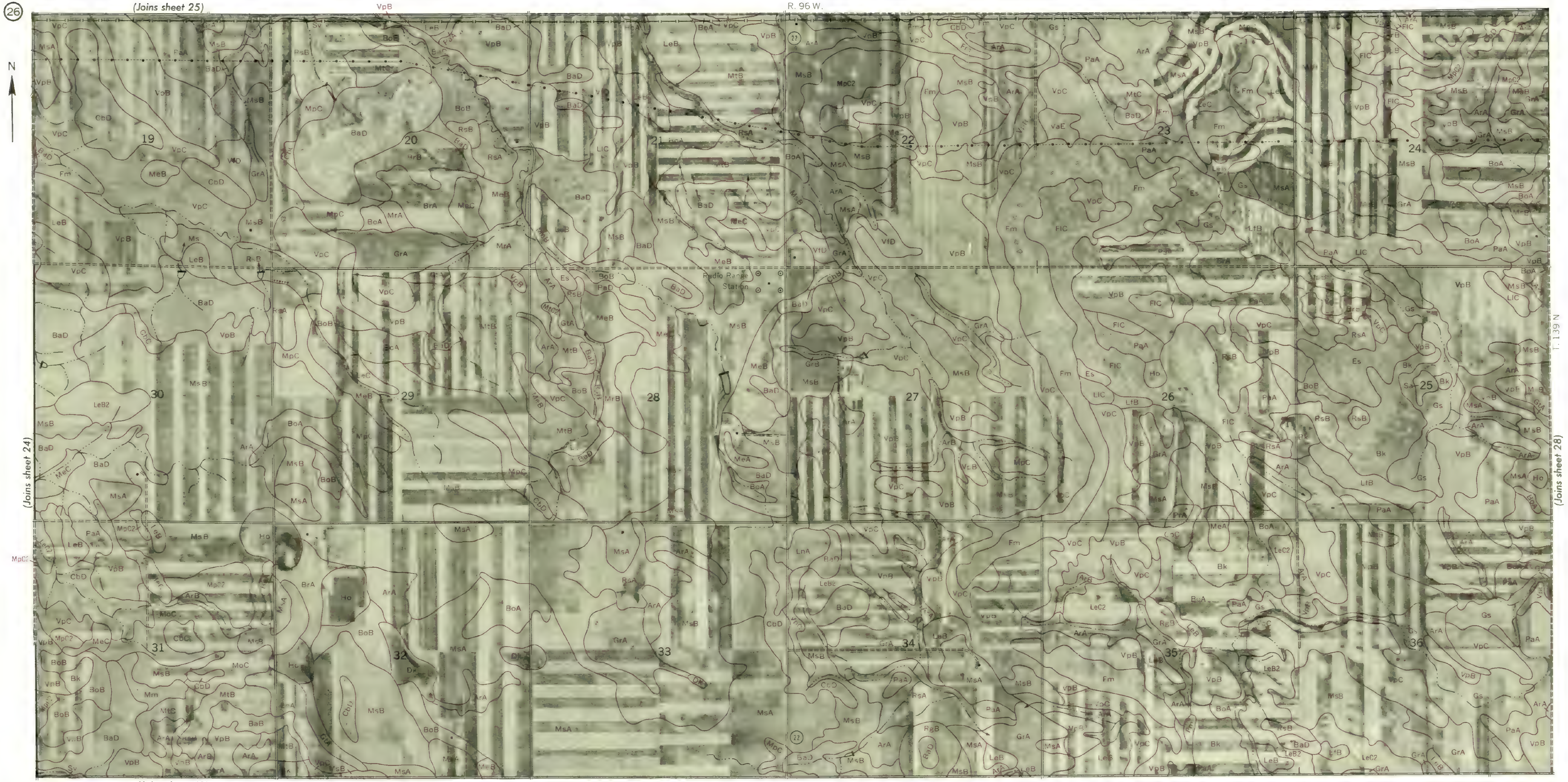

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0 ½ 1 Mile Scale 1:20 000 0 5000 Feet


28
(Joins sheet 27)
R. 95 W.
N
(Joins sheet 26)
(Joins sheet 30)
T. 139 N.
(Joins sheet 45)
19
20
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1 Mile
Scale 1:20 000
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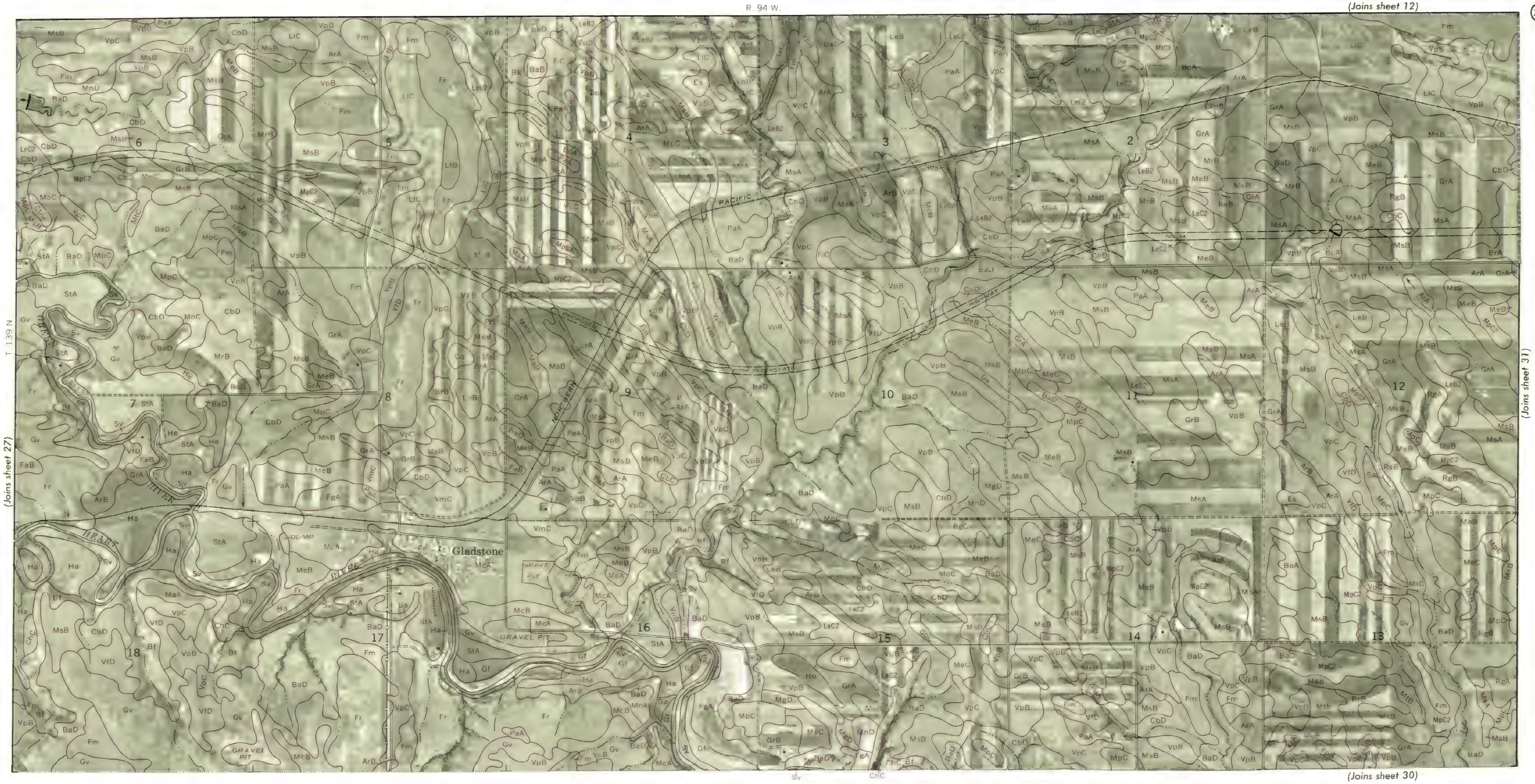
5000 Feet

STARK COUNTY, NORTH DAKOTA — SHEET NUMBER 29



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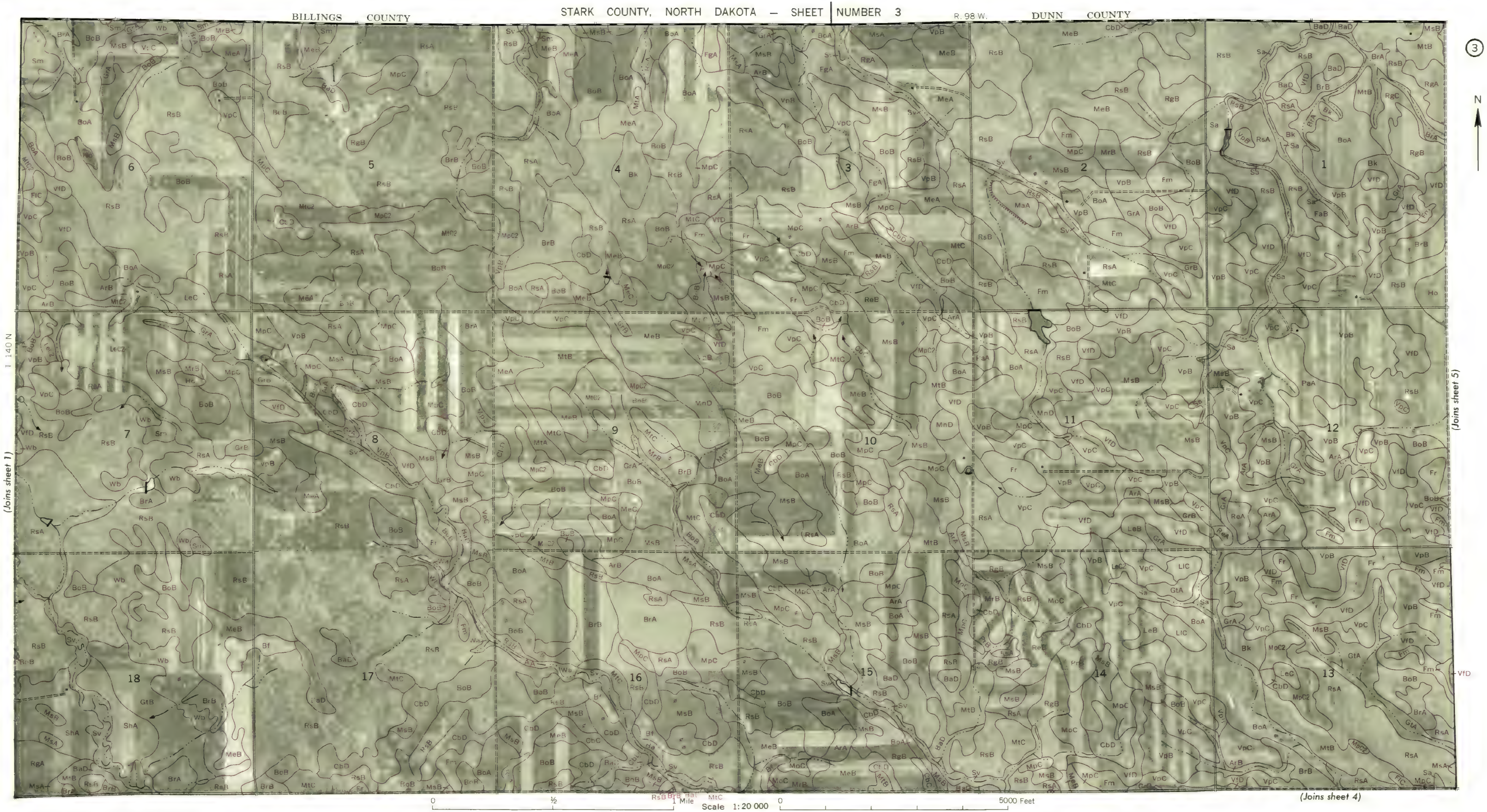
Range, township, and section corners shown on this map are indefinite.

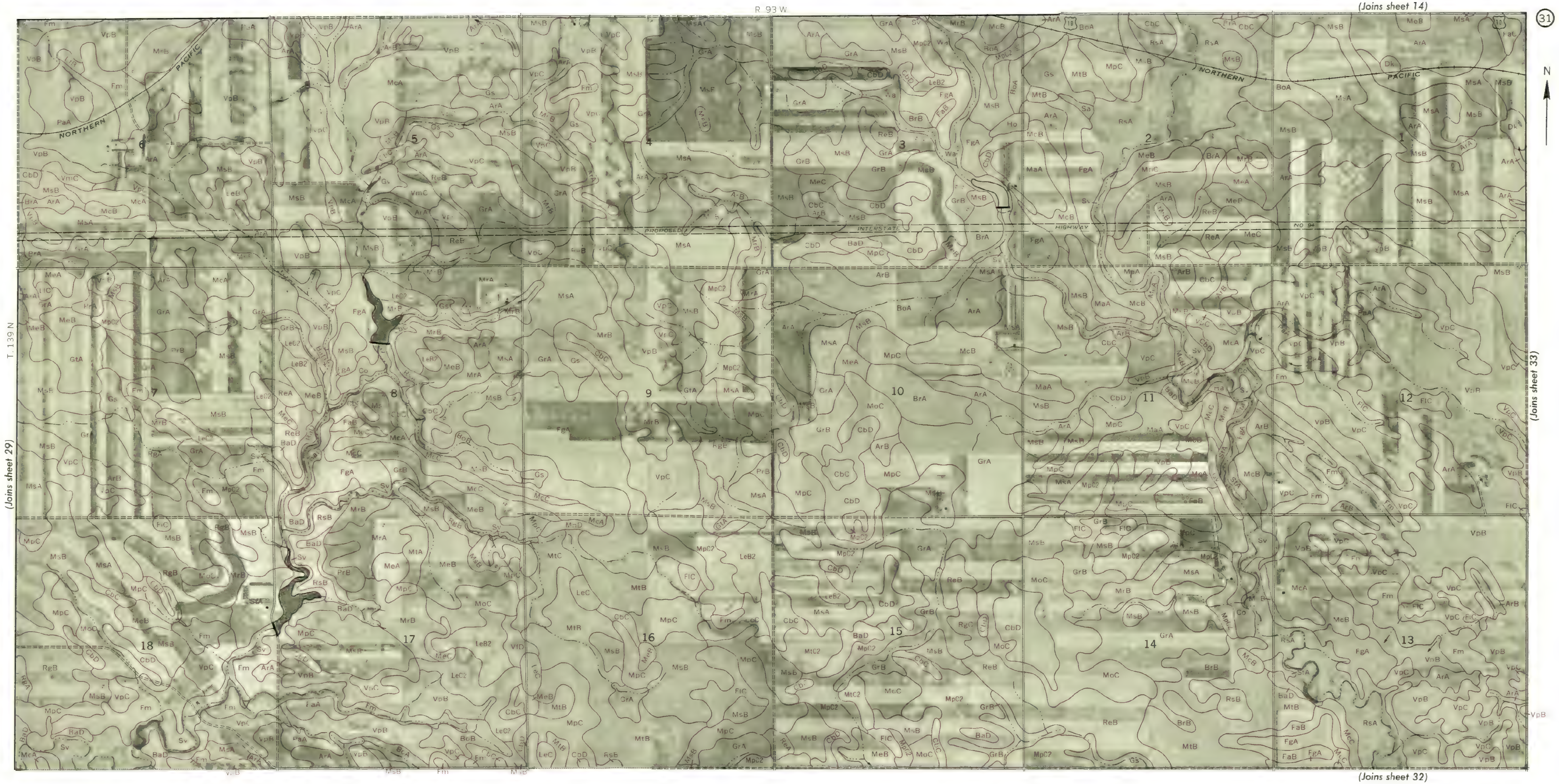
0 ½ 1 Mile Scale 1:20 000 0 5000 Feet



This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

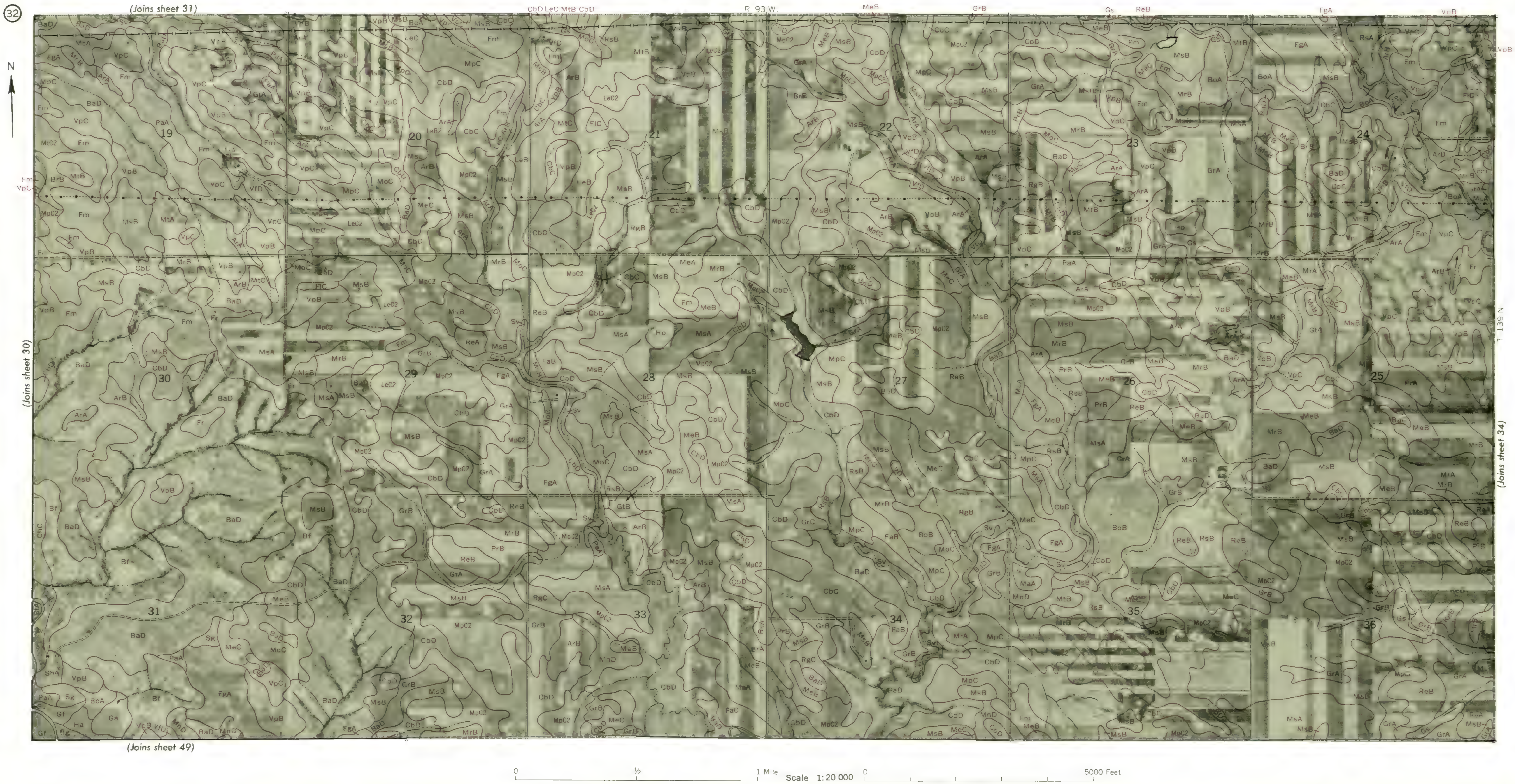
This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Range, township, and section corners shown on this map are indefinite.



Scale 1:20 000

0 ½ 1 Mile

0 5000 Feet


32
(Joins sheet 31)
R. 93 W.
N
(Joins sheet 30)
(Joins sheet 34)
T. 139 N.
(Joins sheet 49)
19
20
21
22
23
24
30
29
28
27
26
25
31
32
33
34
35
36
0
½
1 Mile
Scale 1:20 000
0
5000 Feet

R. 92 W

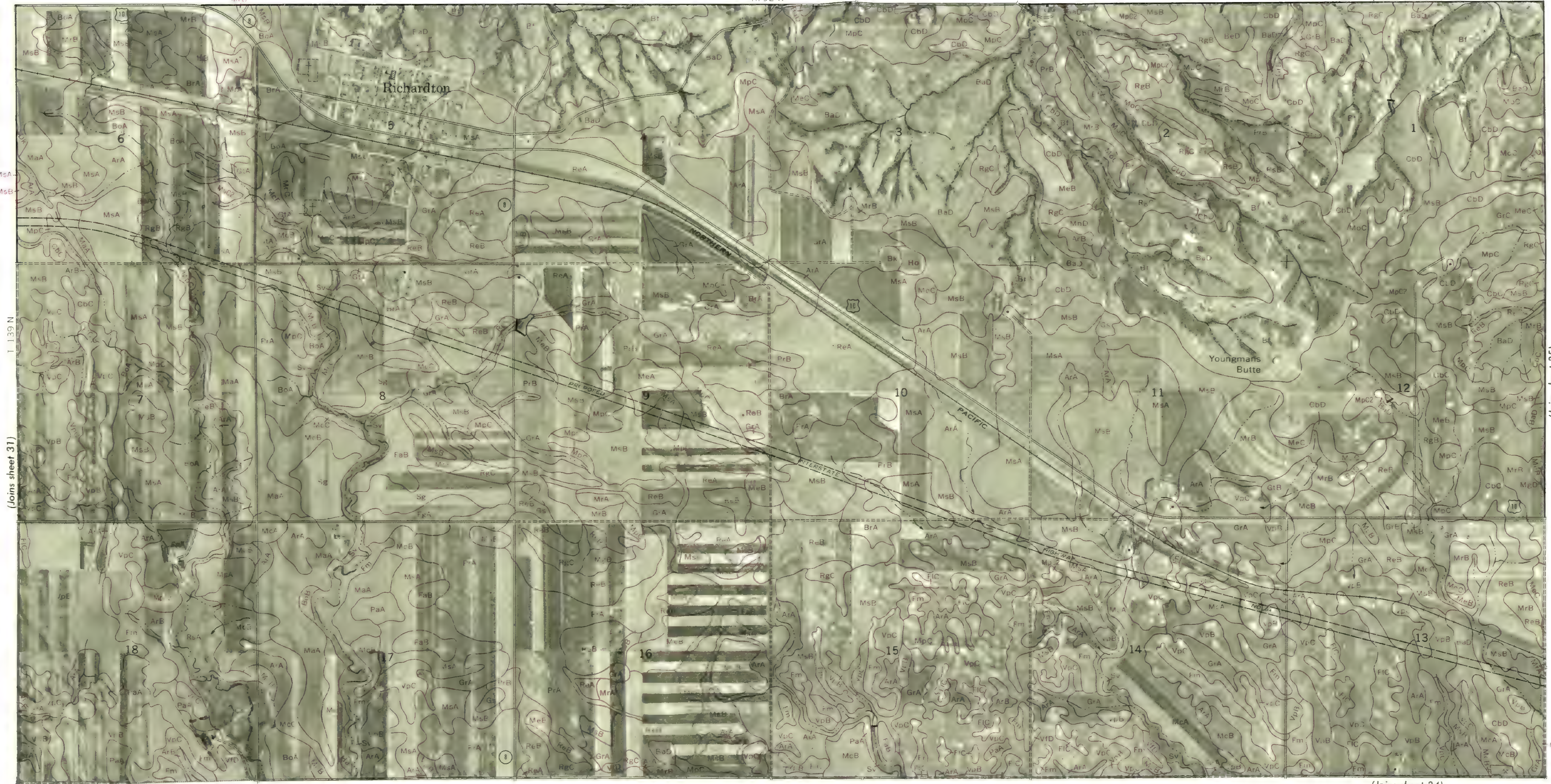
(Joins sheet 16)

N

T. 139 N

(Joins sheet 31)

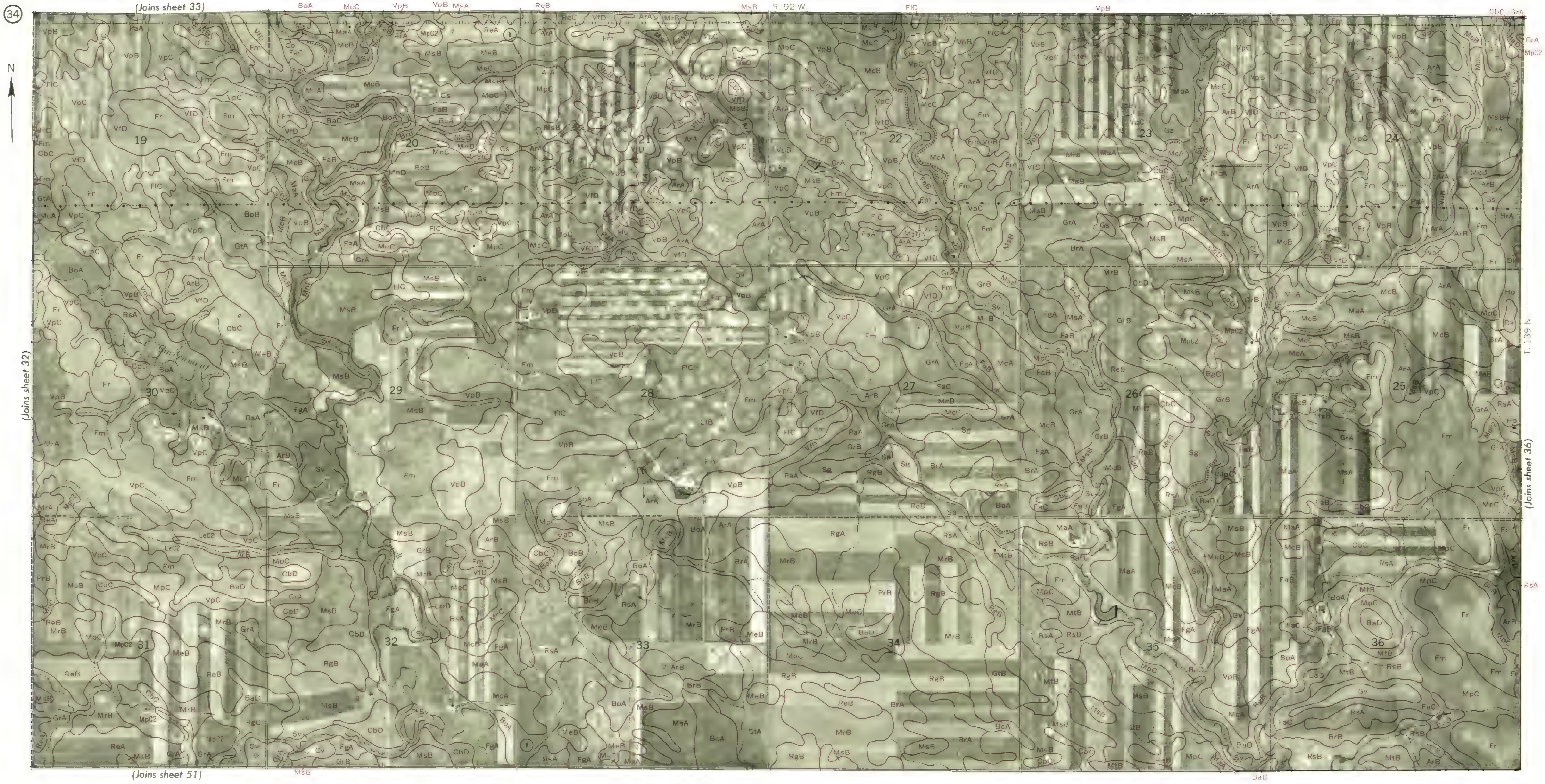
(Joins sheet 35)



(Joins sheet 34)

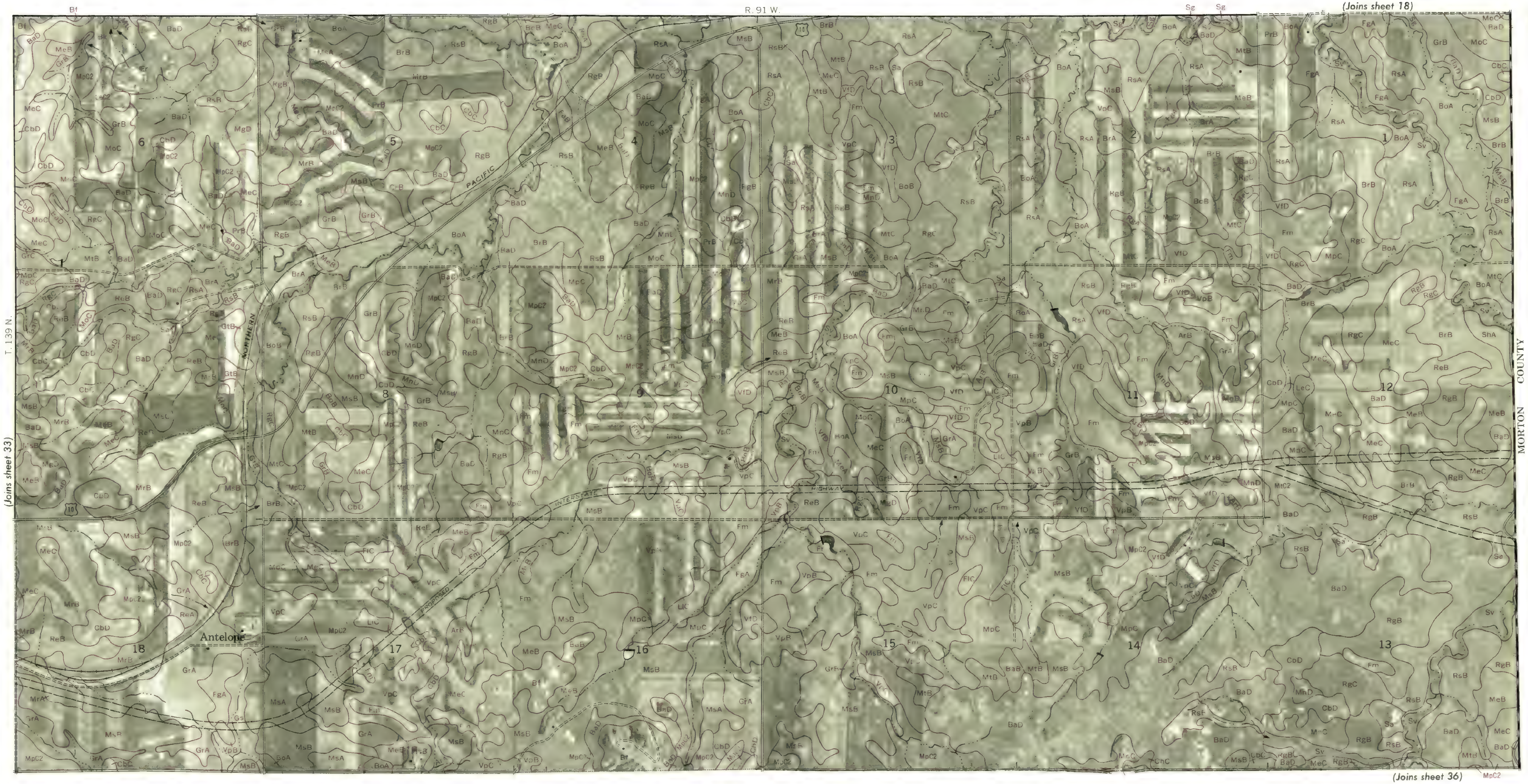
This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet



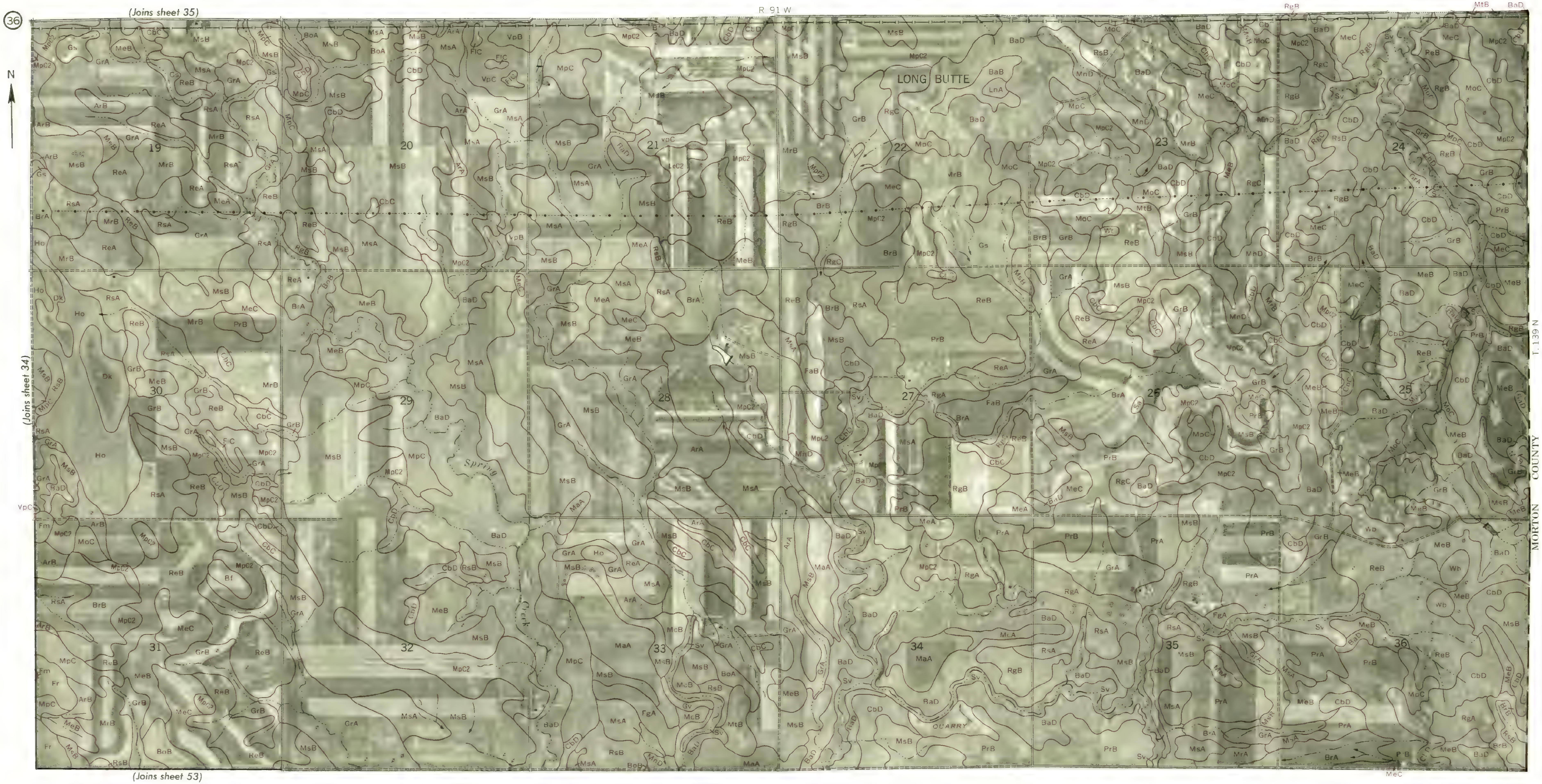
0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

35



This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet



0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

(37)

R. 99 W.

(Joins sheet 20)

N

T. 138 N.

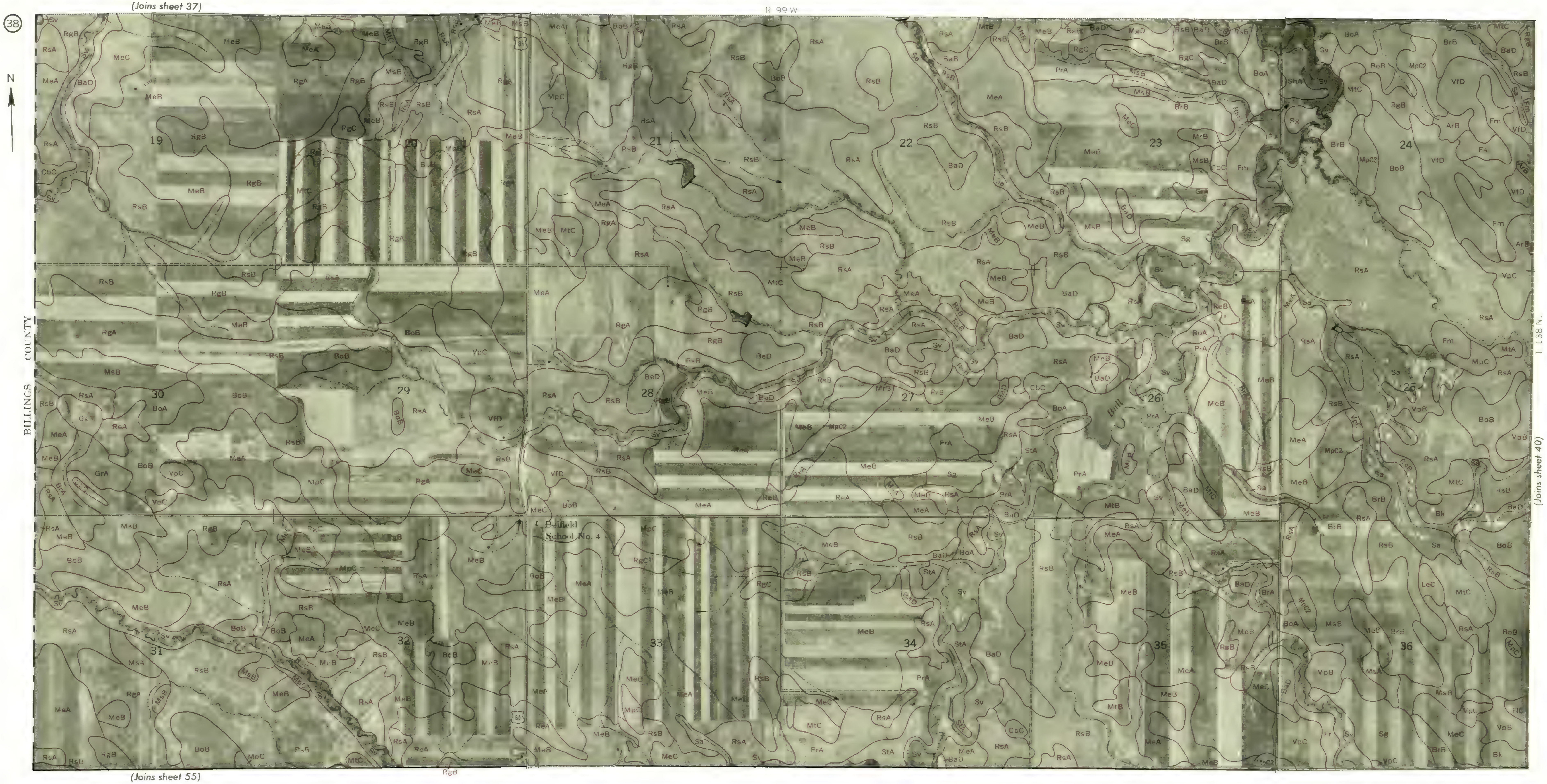
BILLINGS COUNTY

(Joins sheet 39)

(Joins sheet 38)

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

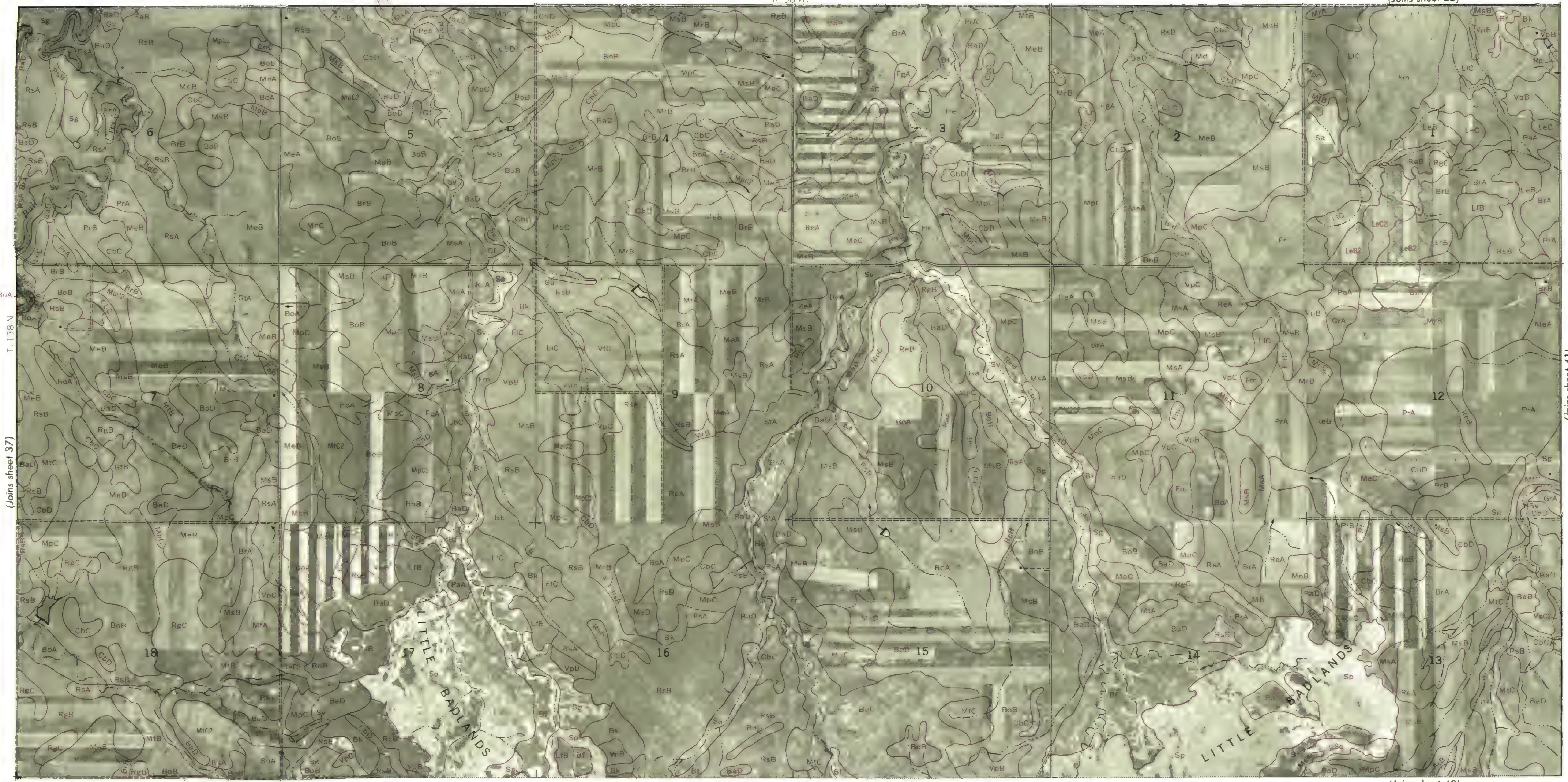
This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Range, township, and section corners shown on this map are indefinite.



Scale 1:20 000

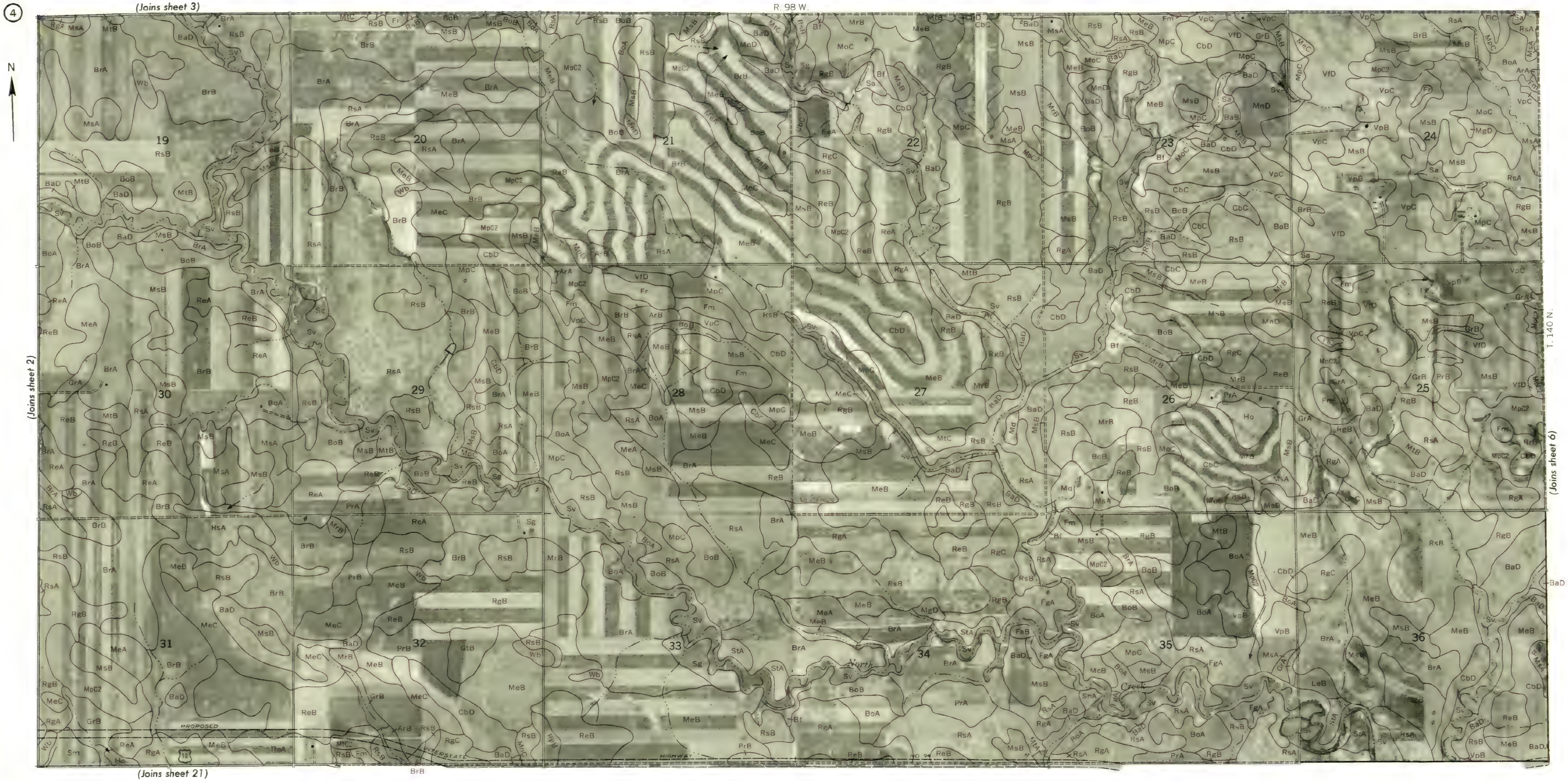
0 ½ 1 Mile

0 5000 Feet

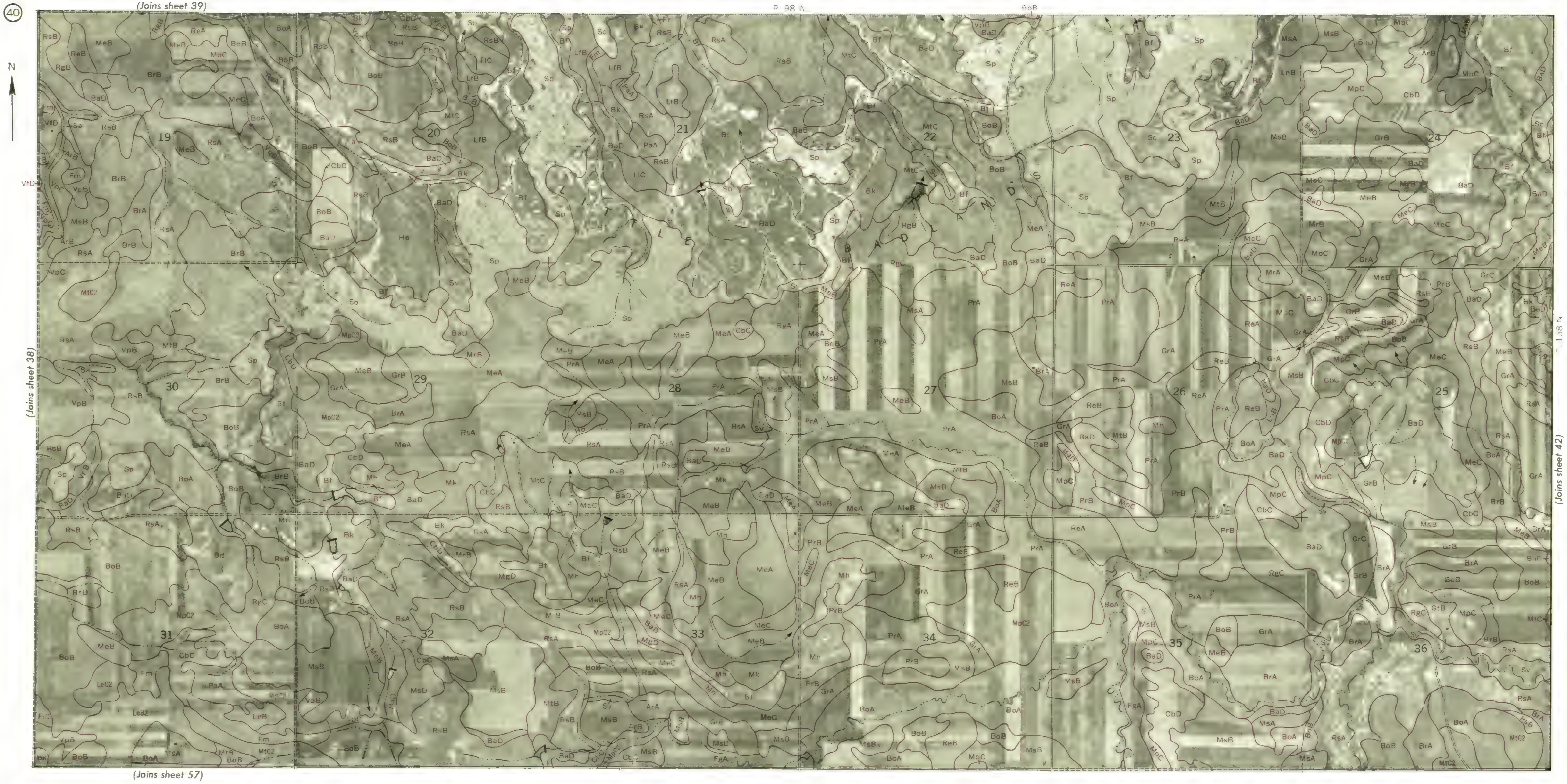


0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

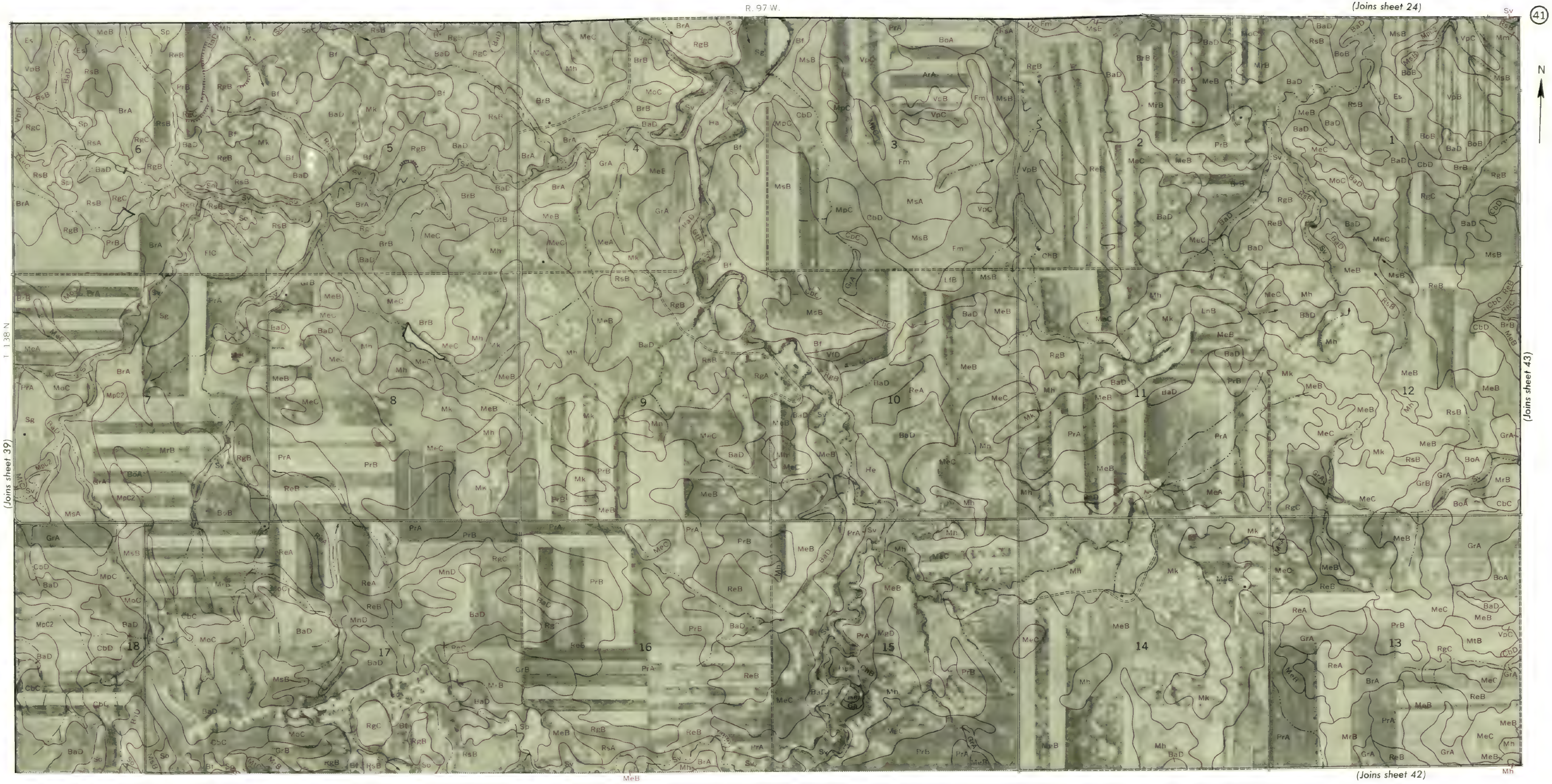
This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Range, township, and section corners shown on this map are indefinite.



0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

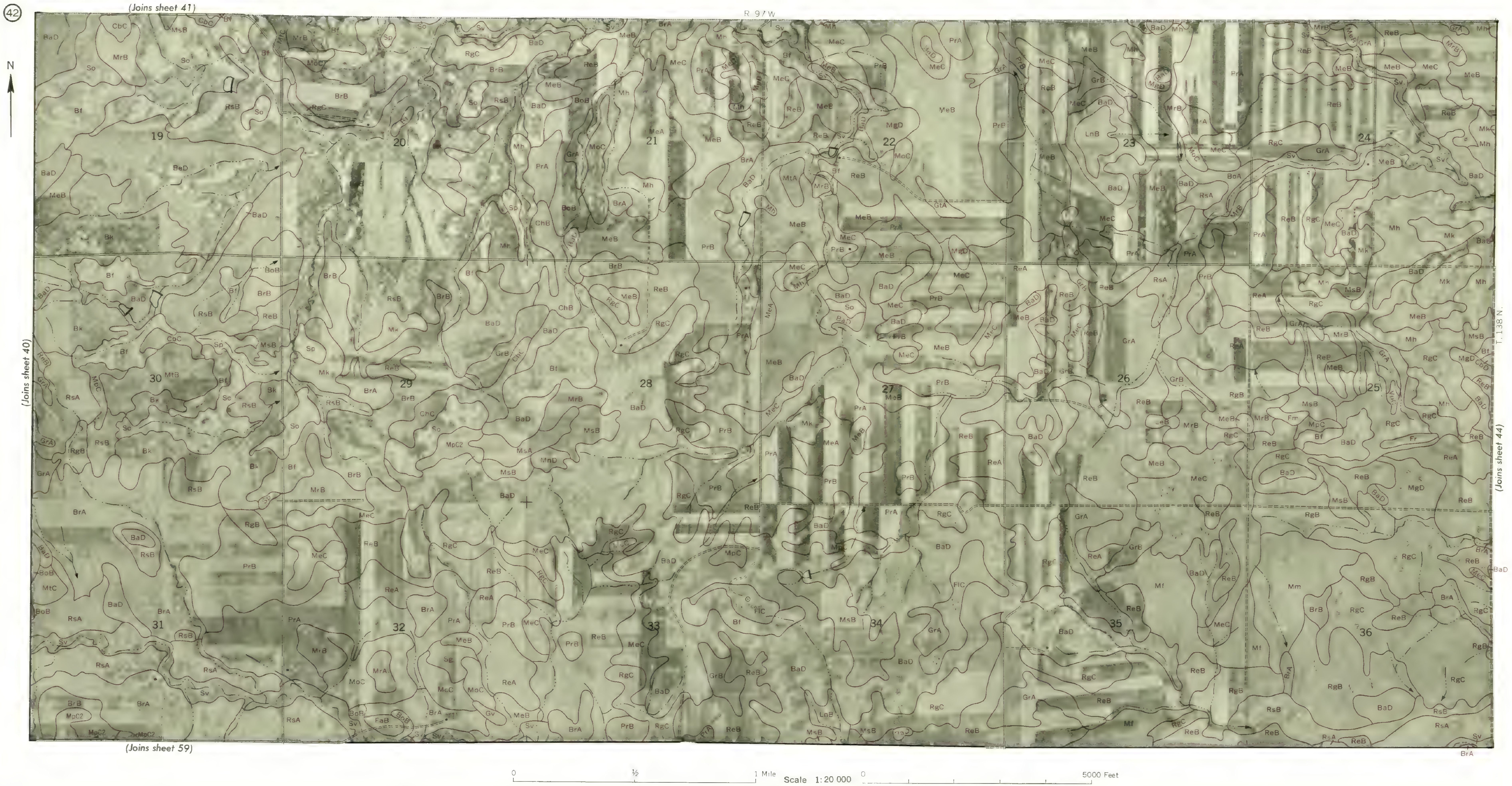


0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

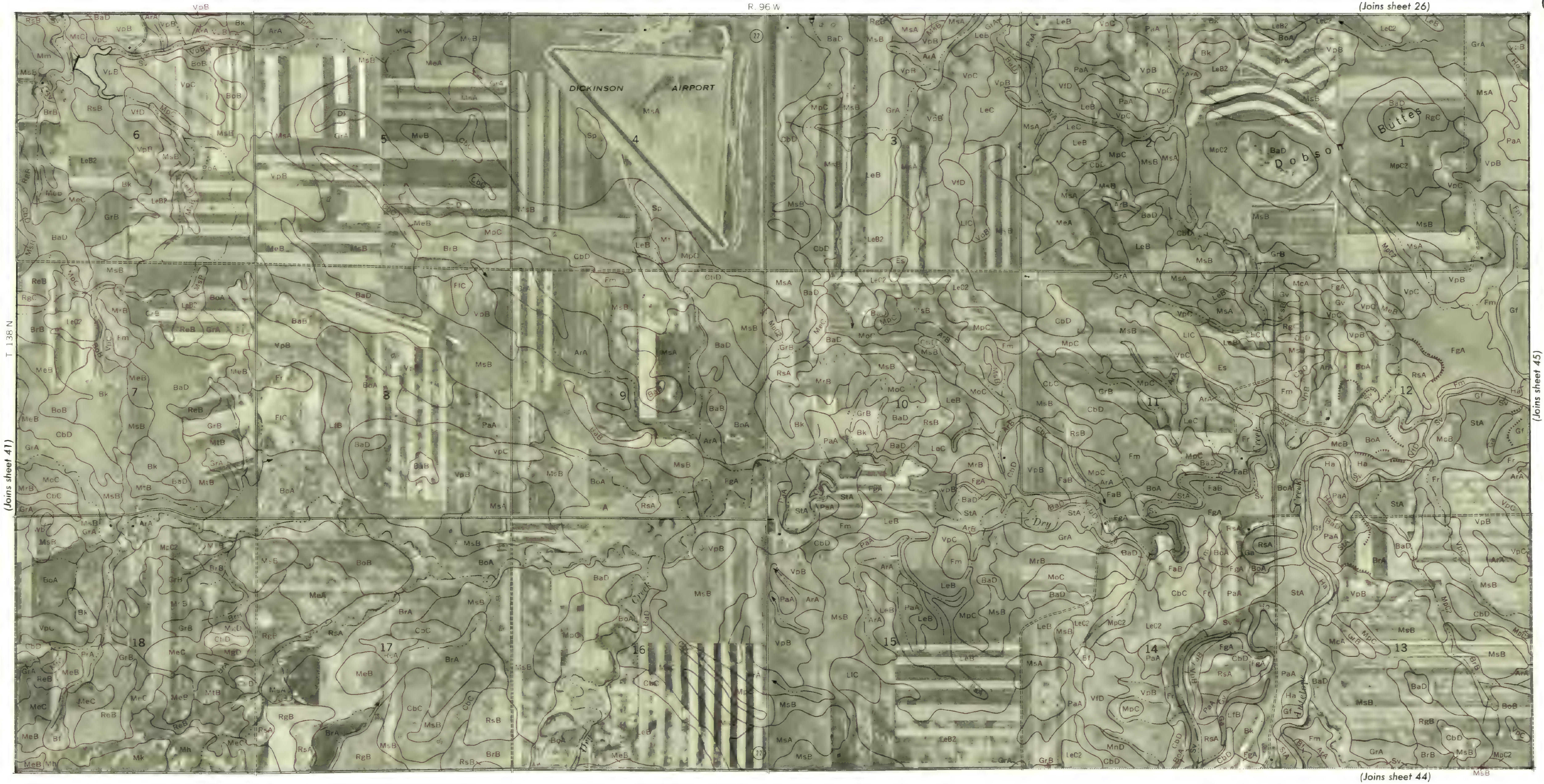


This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

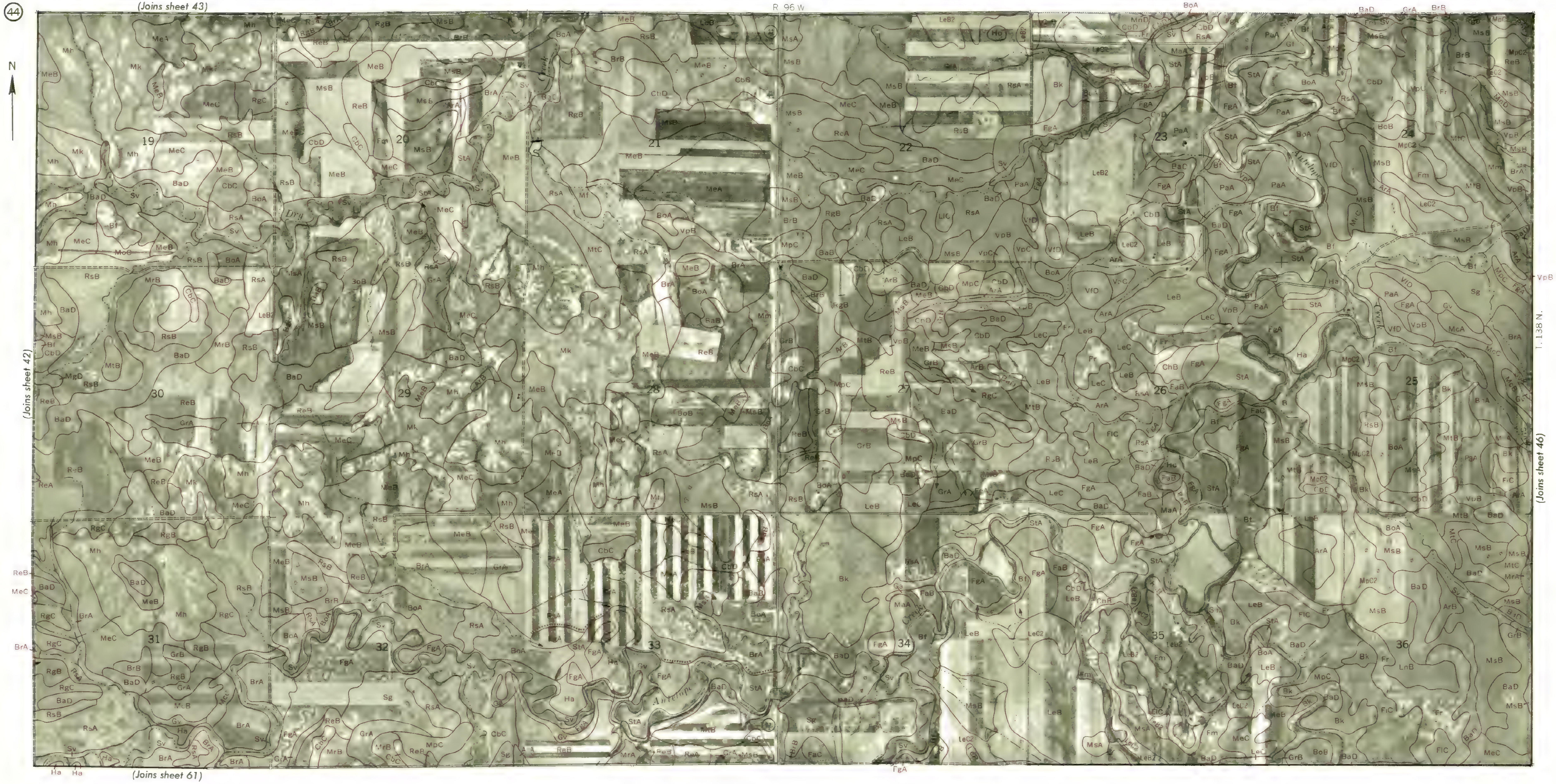

42
N
(Joins sheet 41)
R. 97 W.
(Joins sheet 40)
T. 138 N.
(Joins sheet 44)
(Joins sheet 59)
19
20
21
22
23
24
30
29
28
27
26
25
31
32
33
34
35
36
0
½
1 Mile
Scale 1:20 000
0
5000 Feet

43



This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

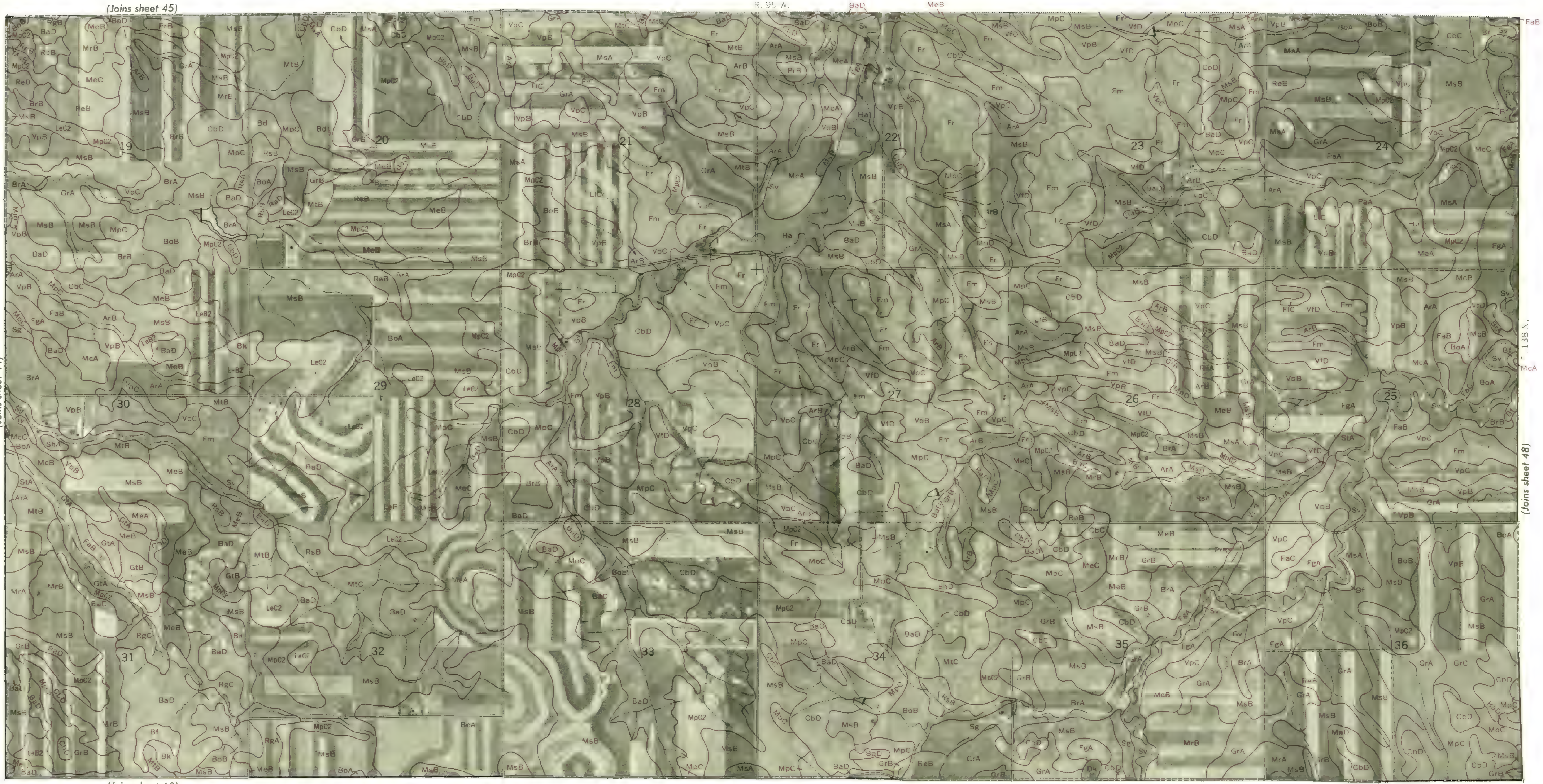


0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Range, township, and section corners shown on this map are indefinite.

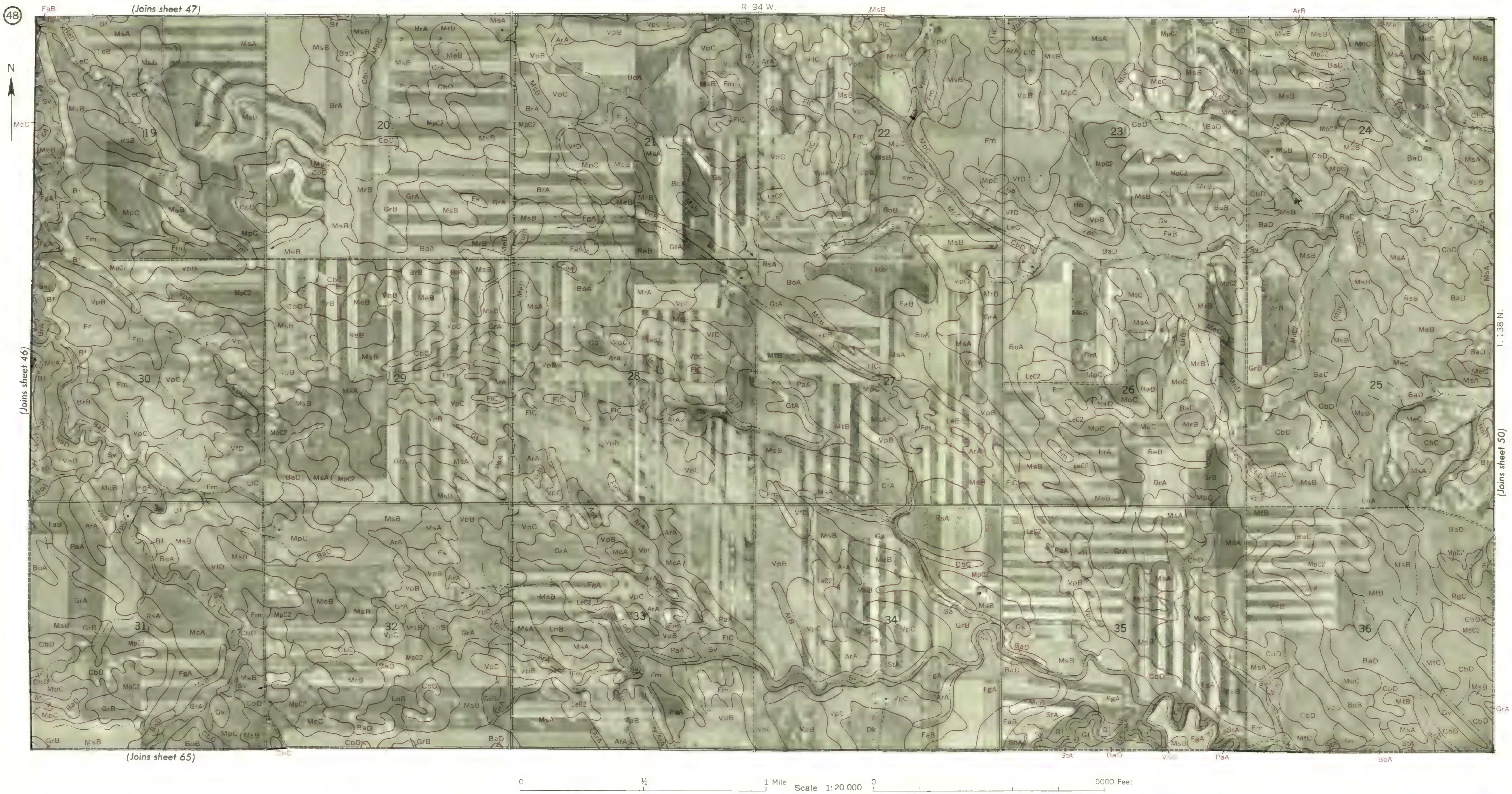
46



0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet


48
(Joins sheet 47)
R. 94 W.
N
(Joins sheet 46)
(Joins sheet 50)
T. 138 N.
(Joins sheet 65)
0
½
1 Mile
Scale 1:20 000
0
5000 Feet

(Joins sheet 32)

49

R. 93 W.

T. 138 N.

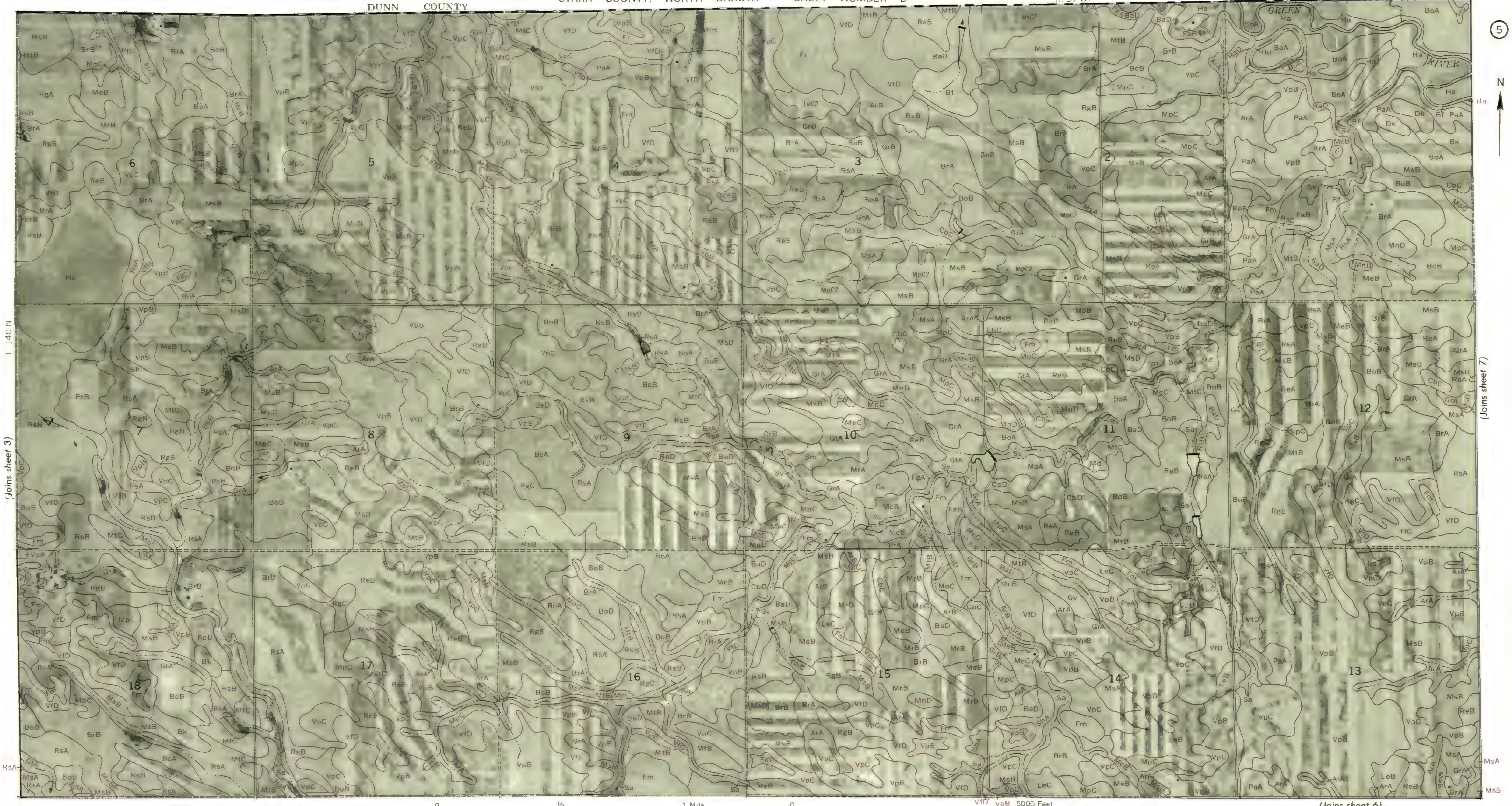
(Joins sheet 47)

(Joins sheet 51)

(Joins sheet 50)

Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet



This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

(50)

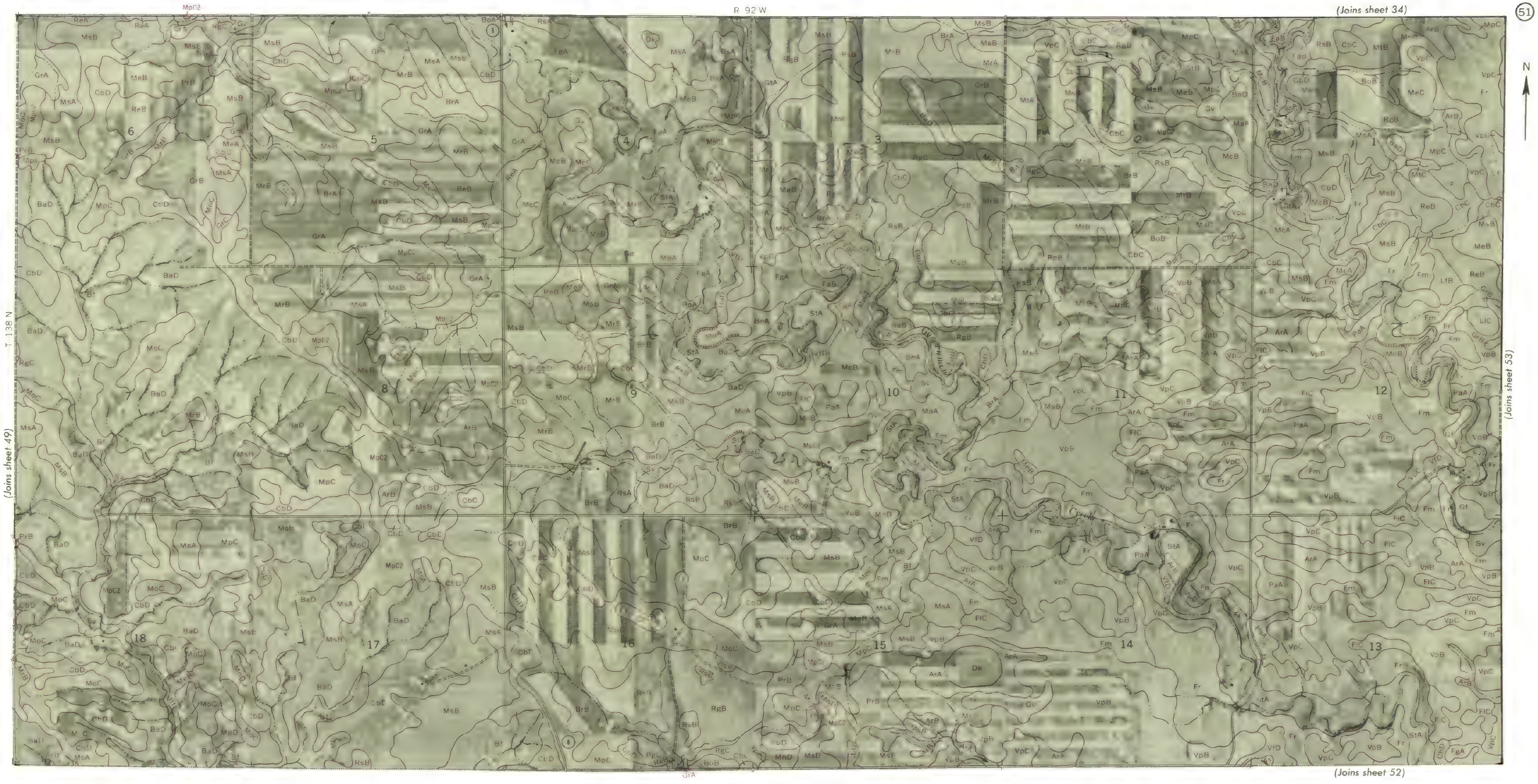
(Joins sheet 49)

(Joins sheet 48)

(Joins sheet 52)

(Joins sheet 67)

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

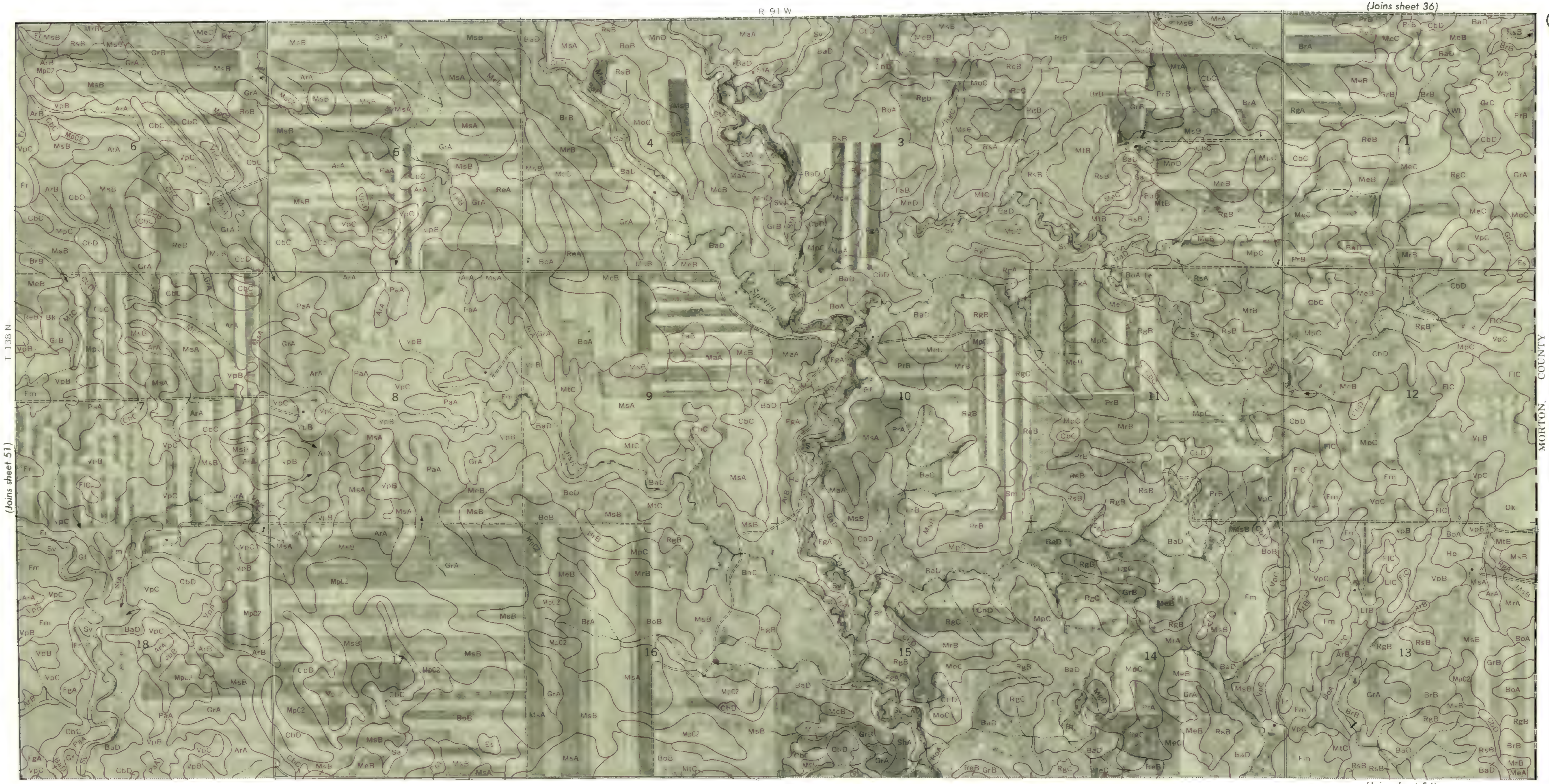


This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

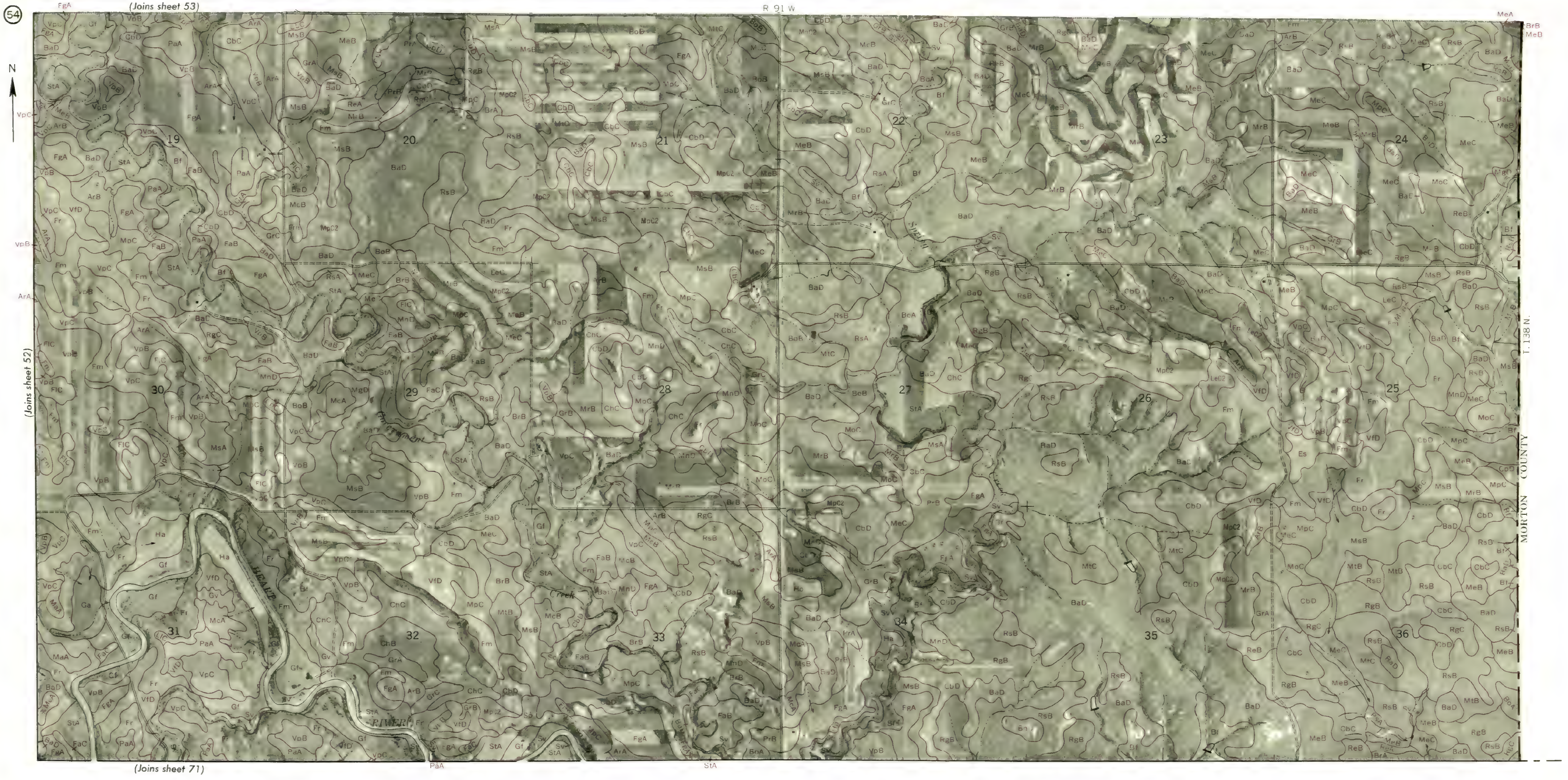
52

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

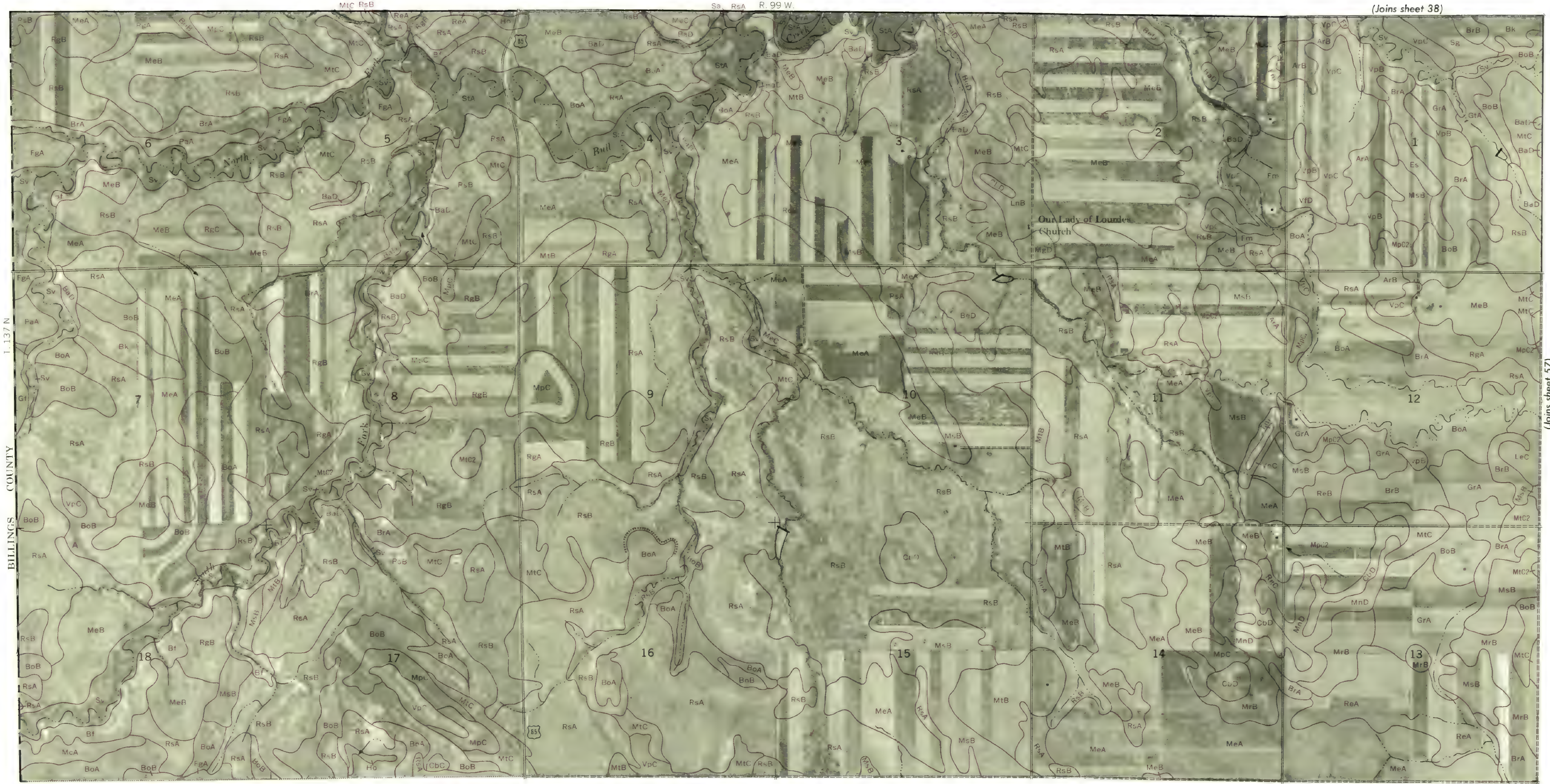


This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet



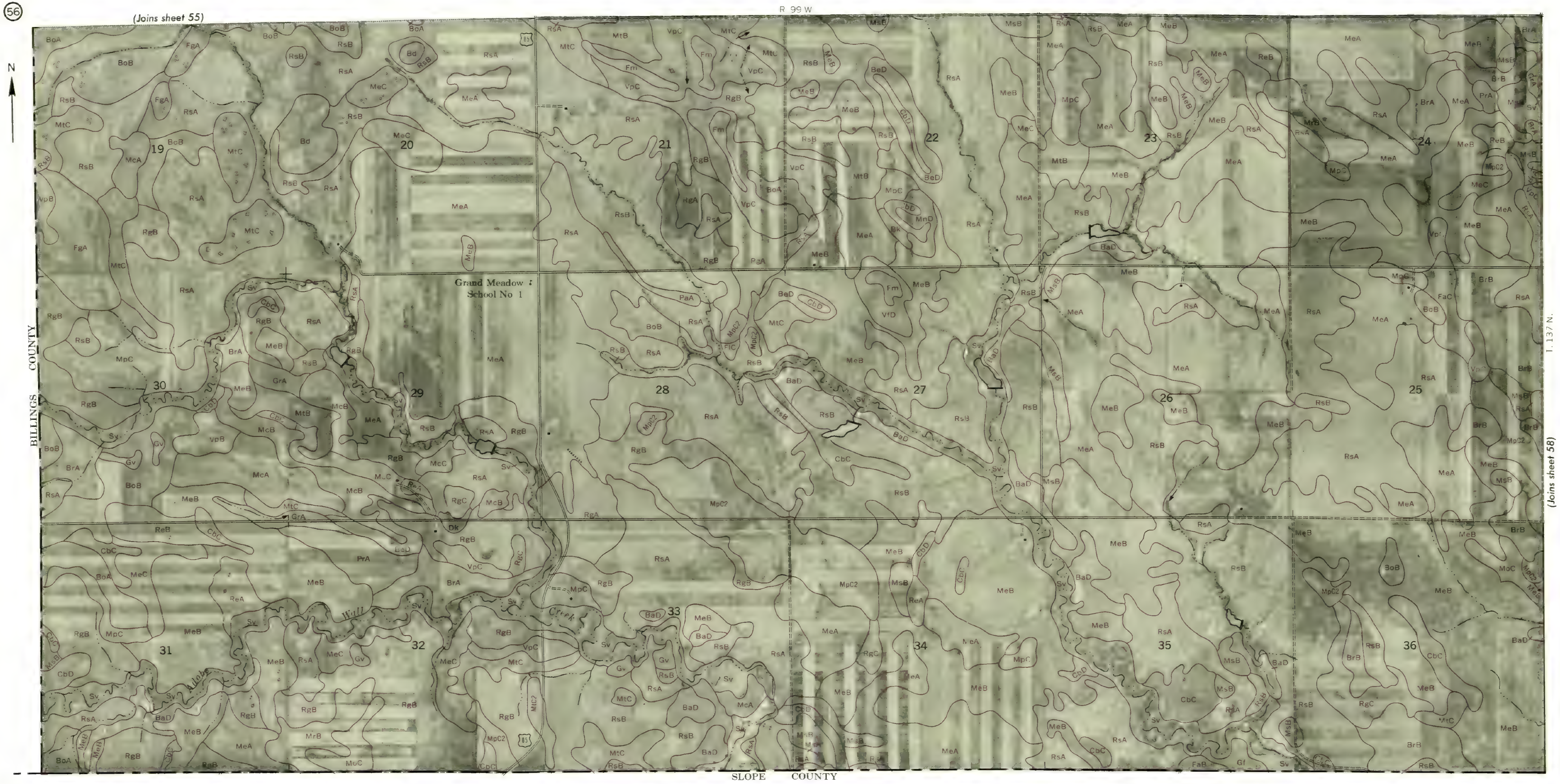
0 ½ 1 Mile Scale 1:20 000 0 5000 Feet



This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the North Dakota Agricultural Experiment Station. Range, township, and section corners shown on this map are indefinite.

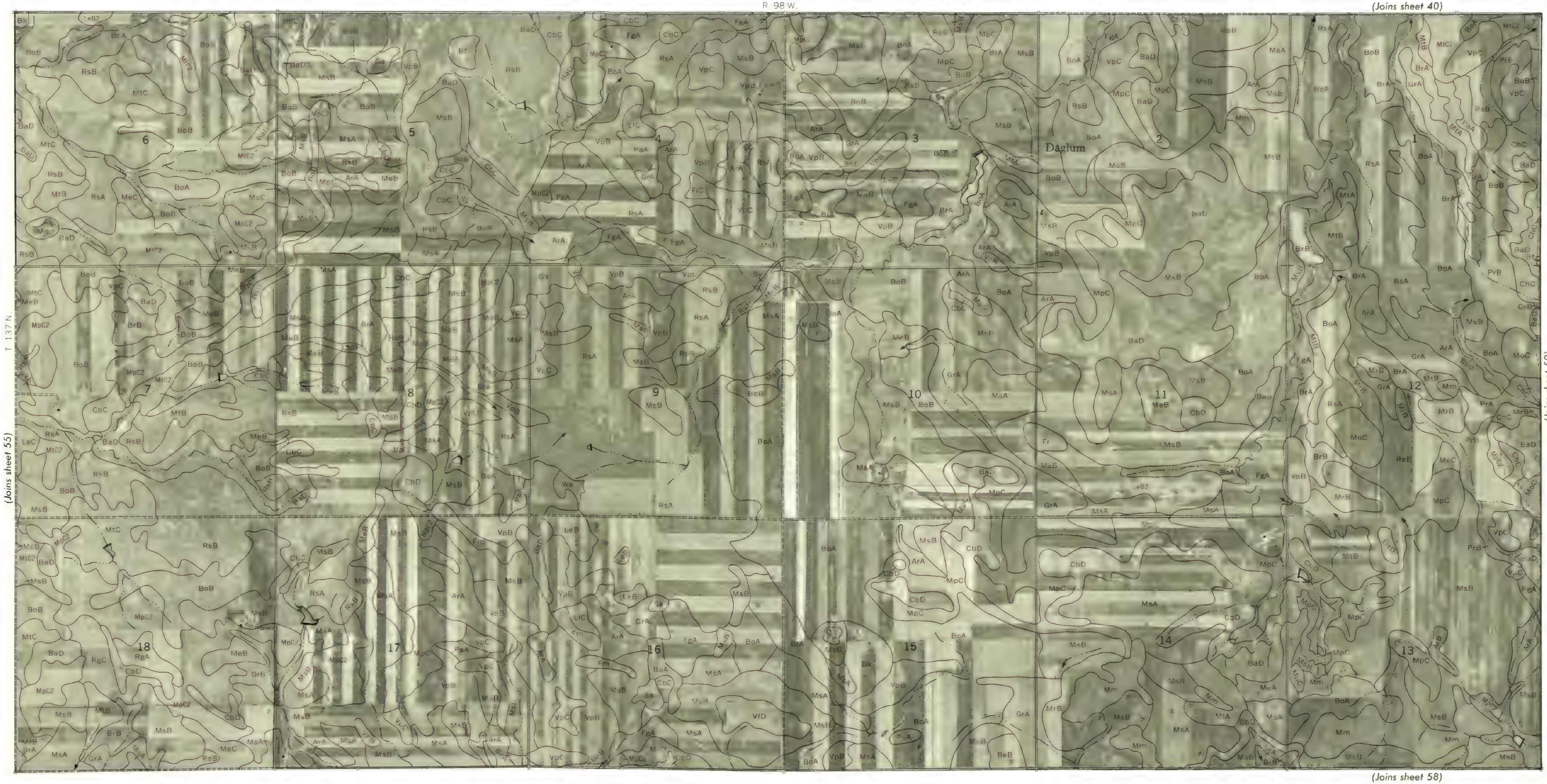
0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

56



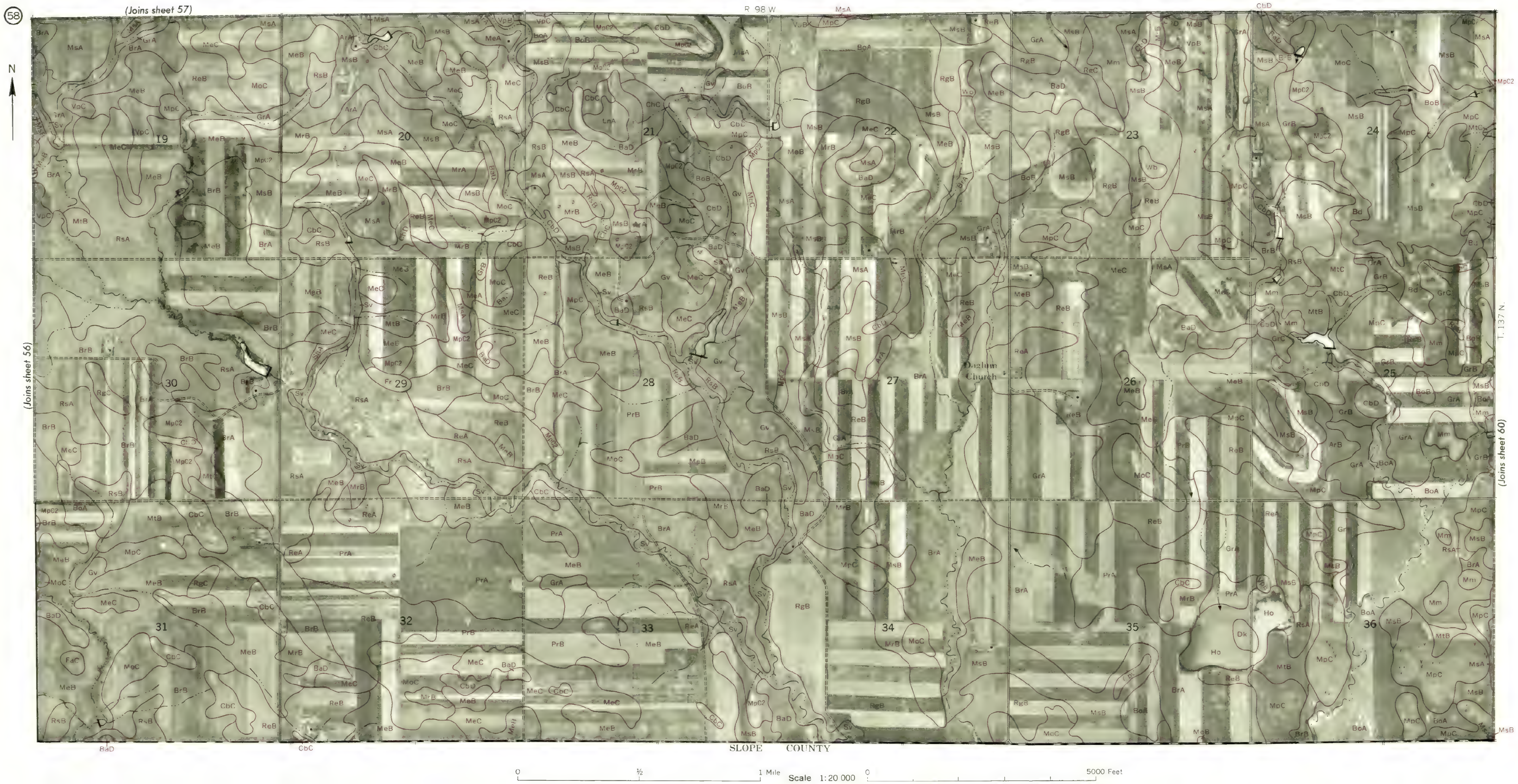
0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

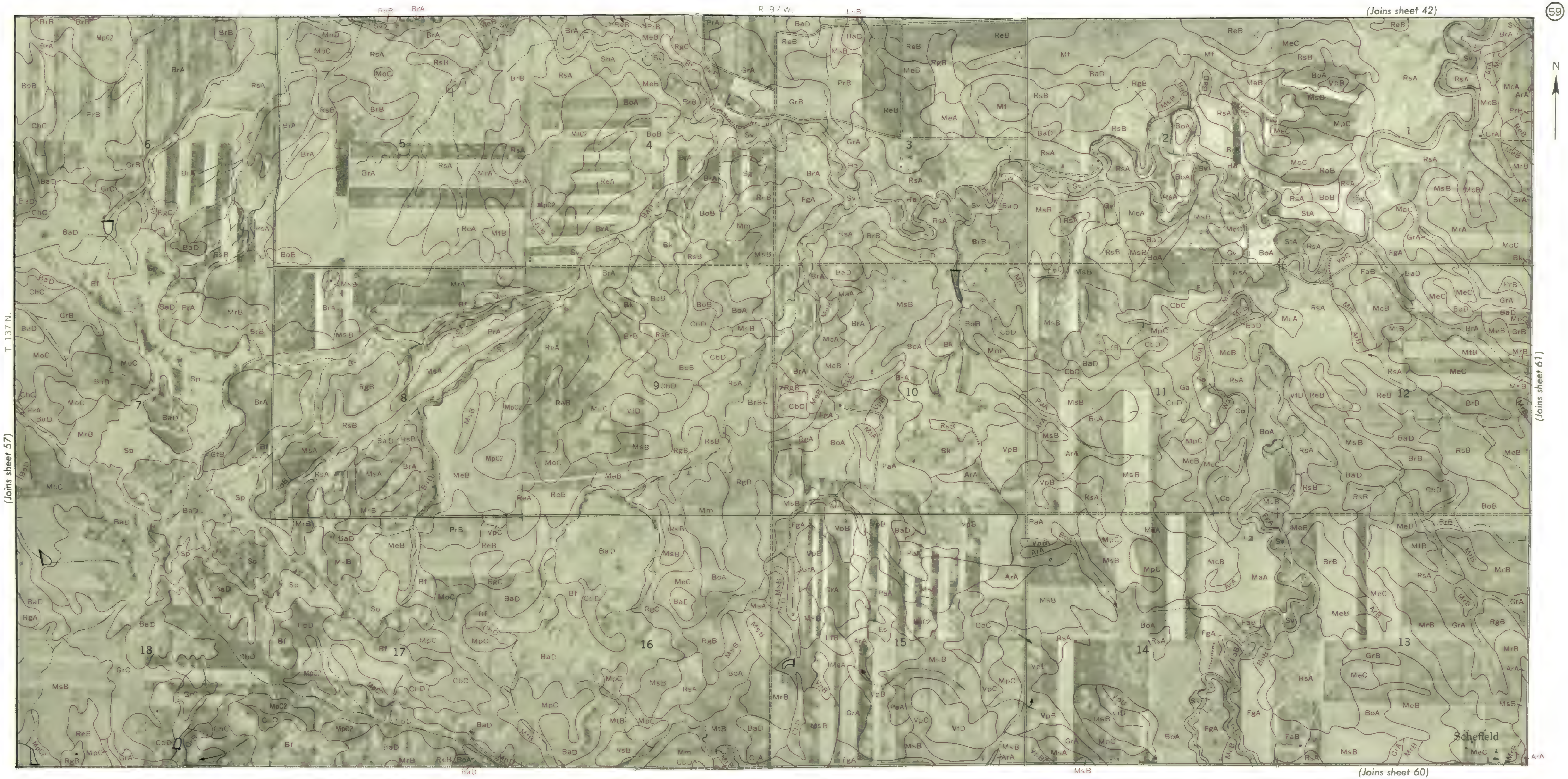
57



This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Range, township, and section corners shown on this map are indefinite.

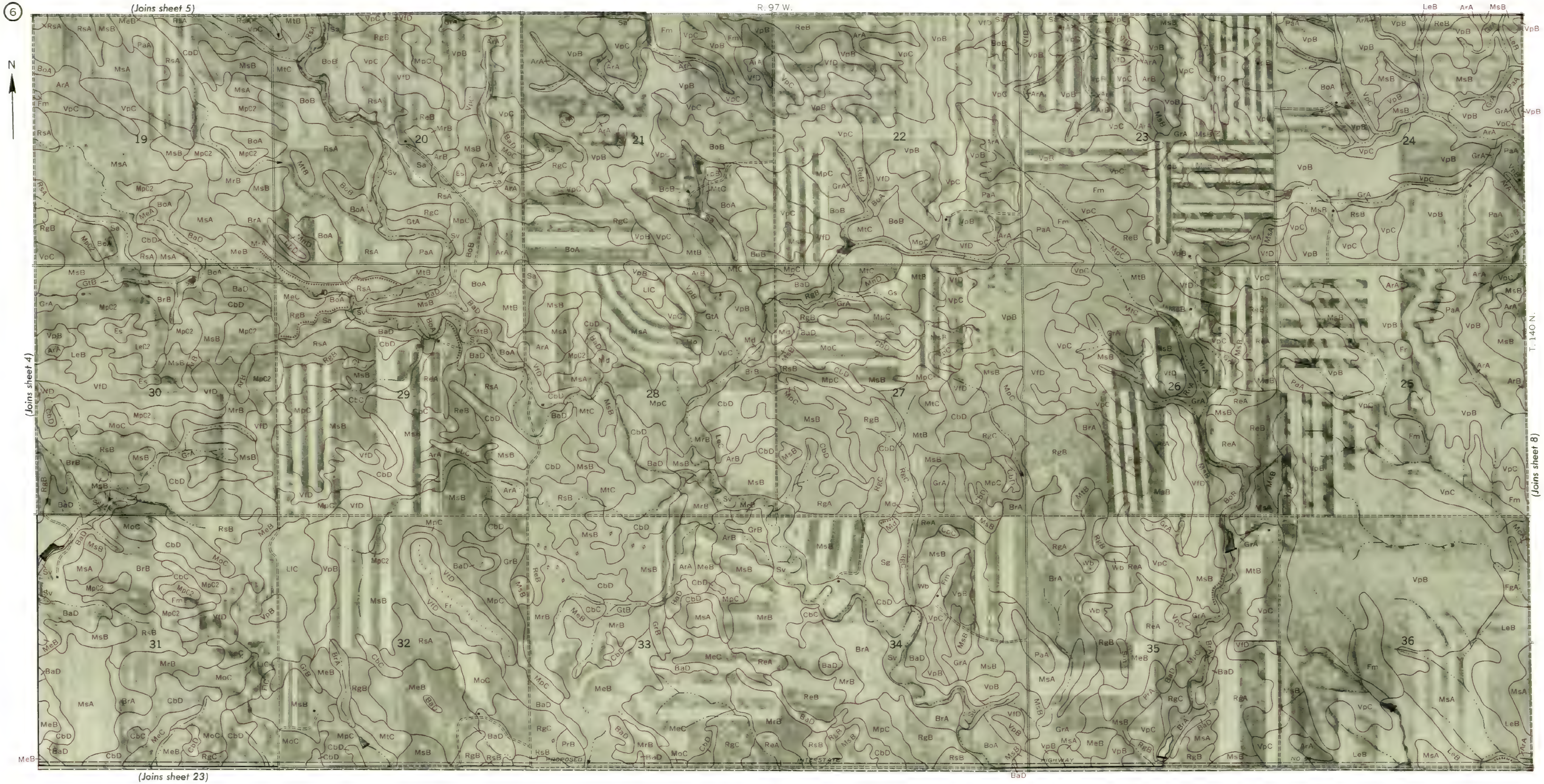
0 ½ 1 Mile Scale 1:20 000 0 5000 Feet


58
(Joins sheet 57)
R 98 W
N
T. 137 N.
(Joins sheet 56)
(Joins sheet 60)
19
20
21
22
23
24
30
29
28
27
26
25
31
32
33
34
35
36
Daglum Church
SLOPE COUNTY
0 ½ 1 Mile
Scale 1:20 000
0 5000 Feet



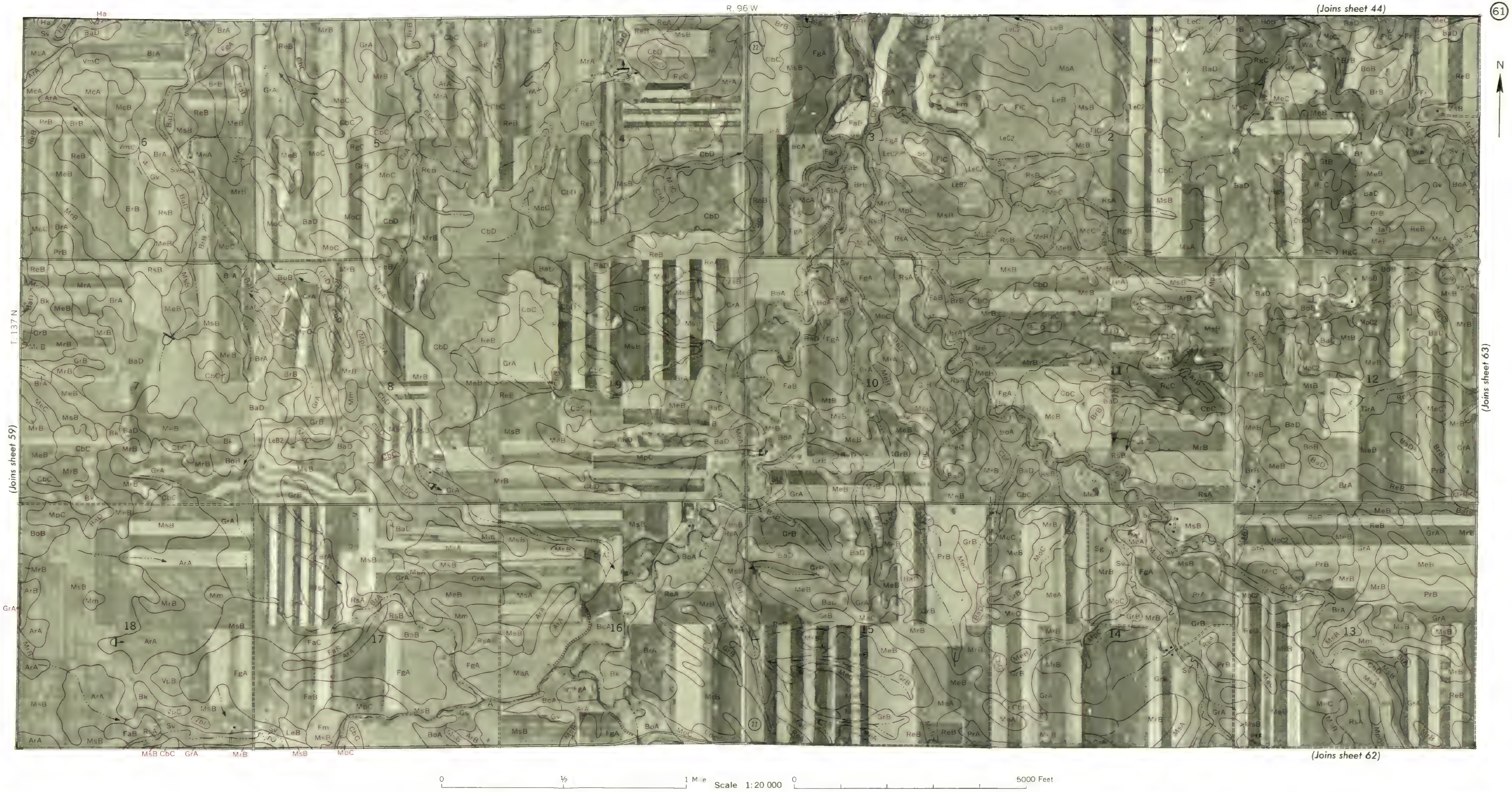
This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet



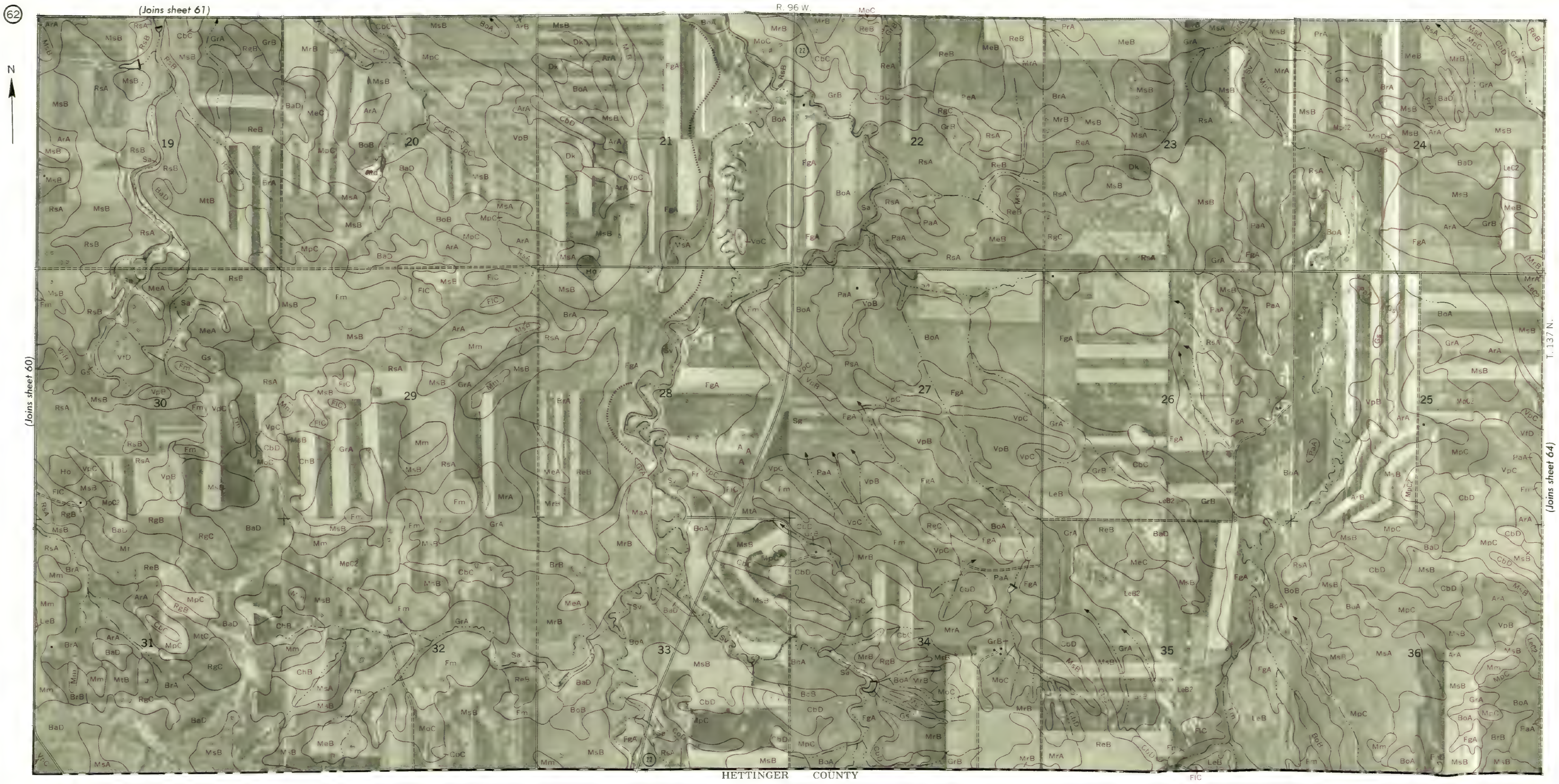
0 ½ 1 Mile Scale 1:20 000 0 5000 Feet


60
(Joins sheet 59)
R. 97 W.
N
(Joins sheet 58)
(Joins sheet 62)
T. 137 N.
19
20
21
22
23
24
30
29
28
27
26
25
31
32
33
34
35
36
SLOPE COUNTY
HETTINGER COUNTY
0
½
1 Mile
Scale 1:20 000
0
5000 Feet

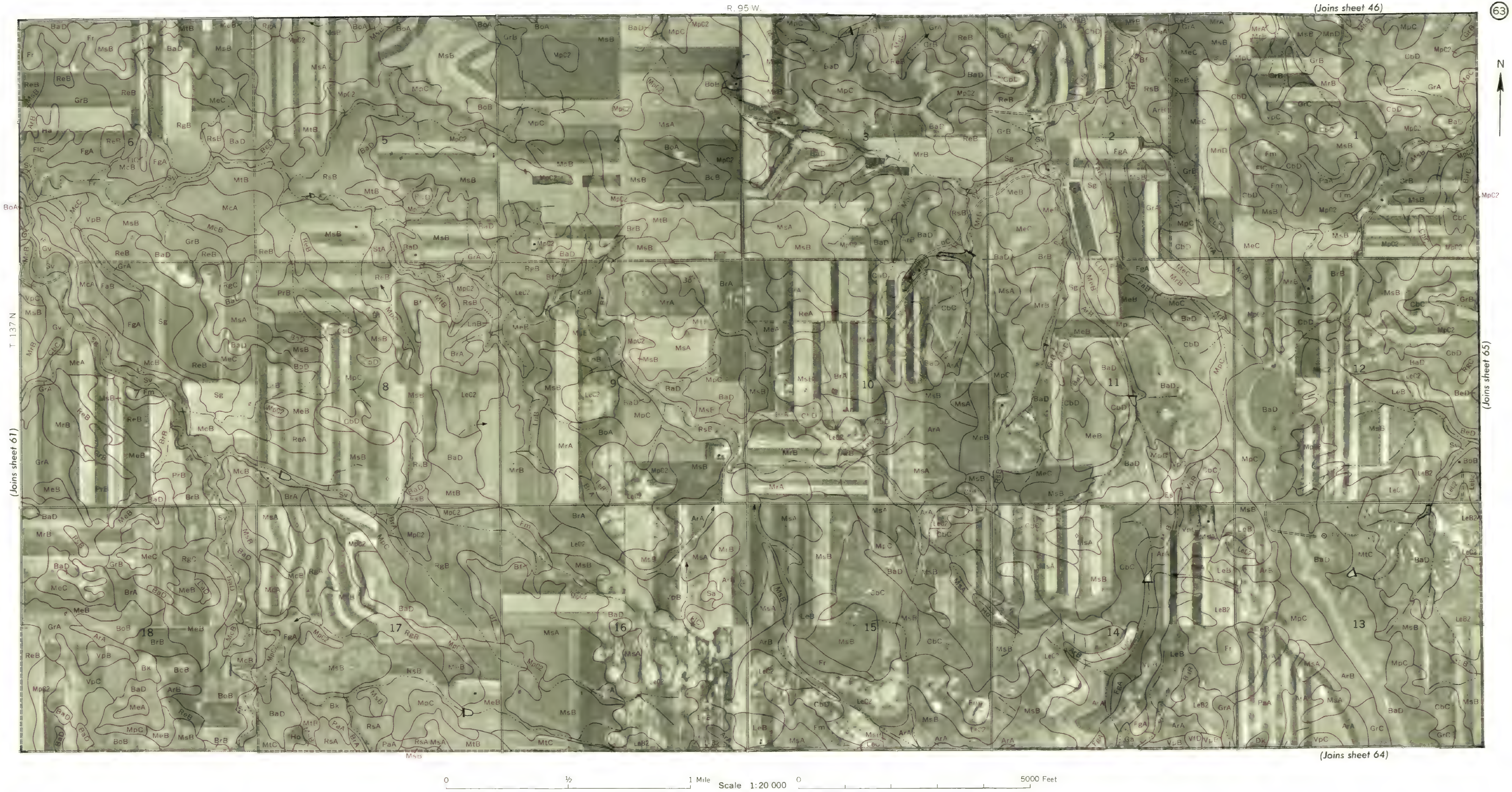


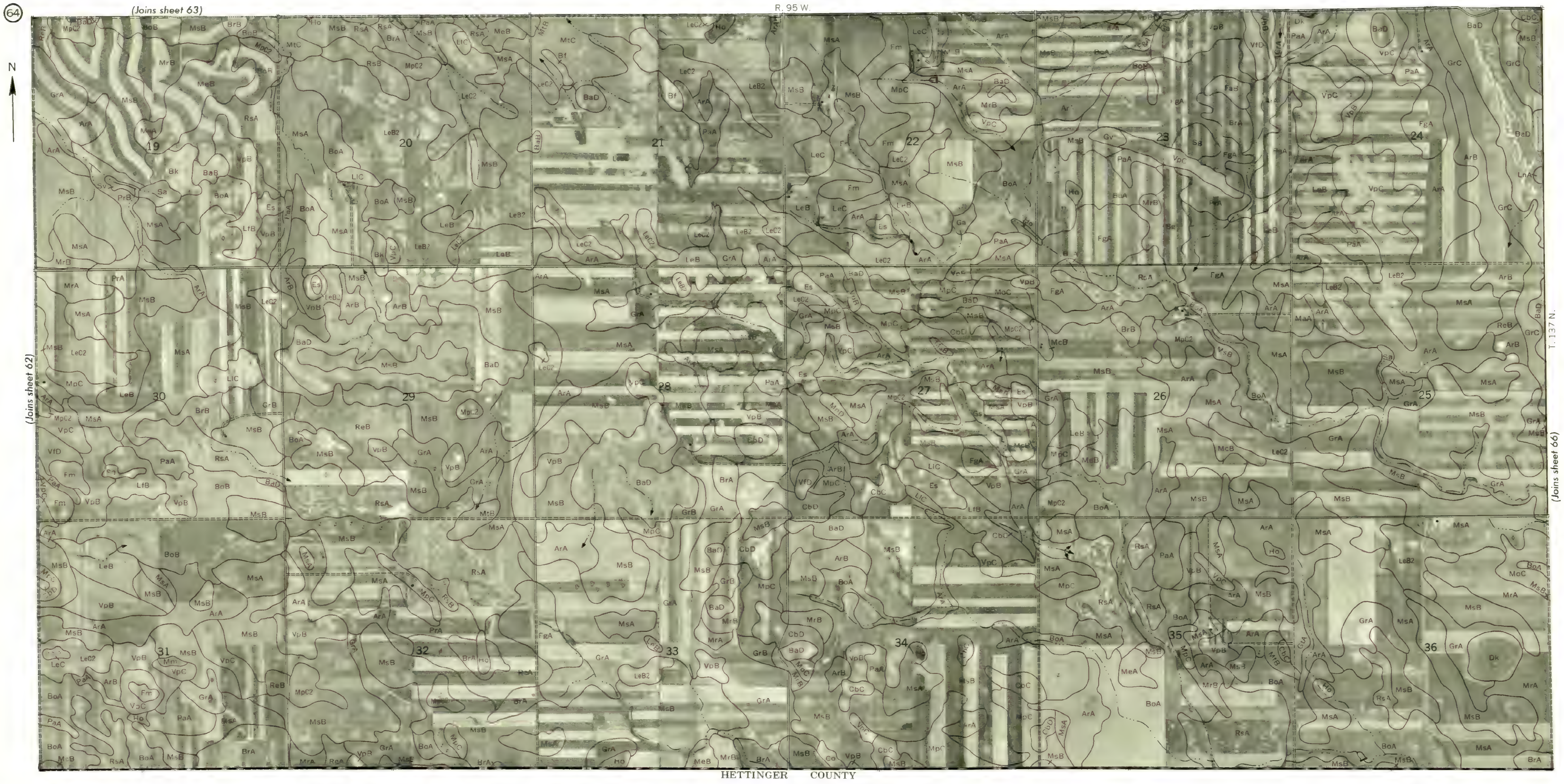
This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.

Range, township, and section corners shown on this map are indefinite.



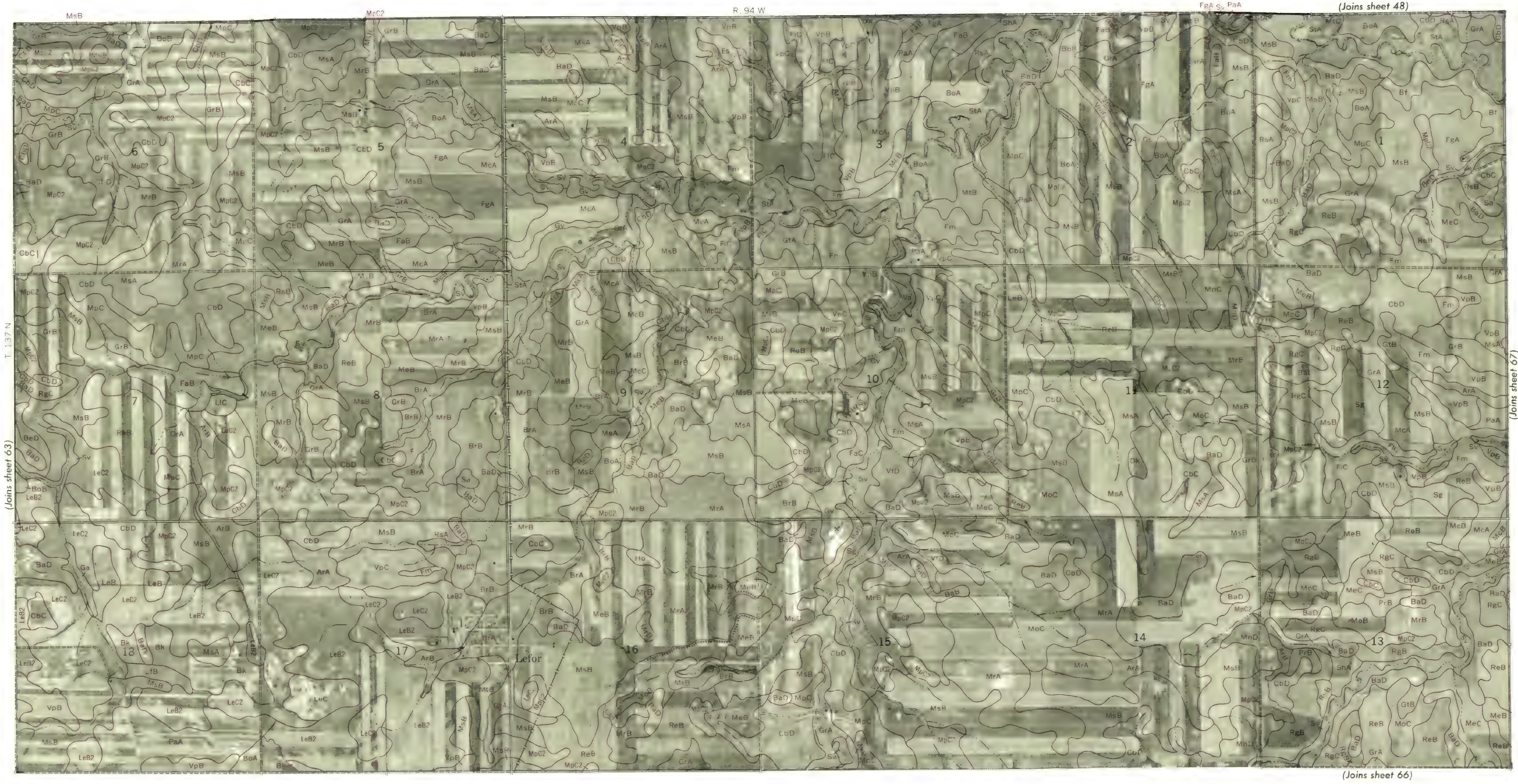
0 ½ 1 Mile Scale 1:20 000 0 5000 Feet


R. 95 W.
(Joins sheet 46)
63
N
T. 137 N
(Joins sheet 61)
(Joins sheet 65)
(Joins sheet 64)
0
½
1 Mile
Scale 1:20 000
0
5000 Feet

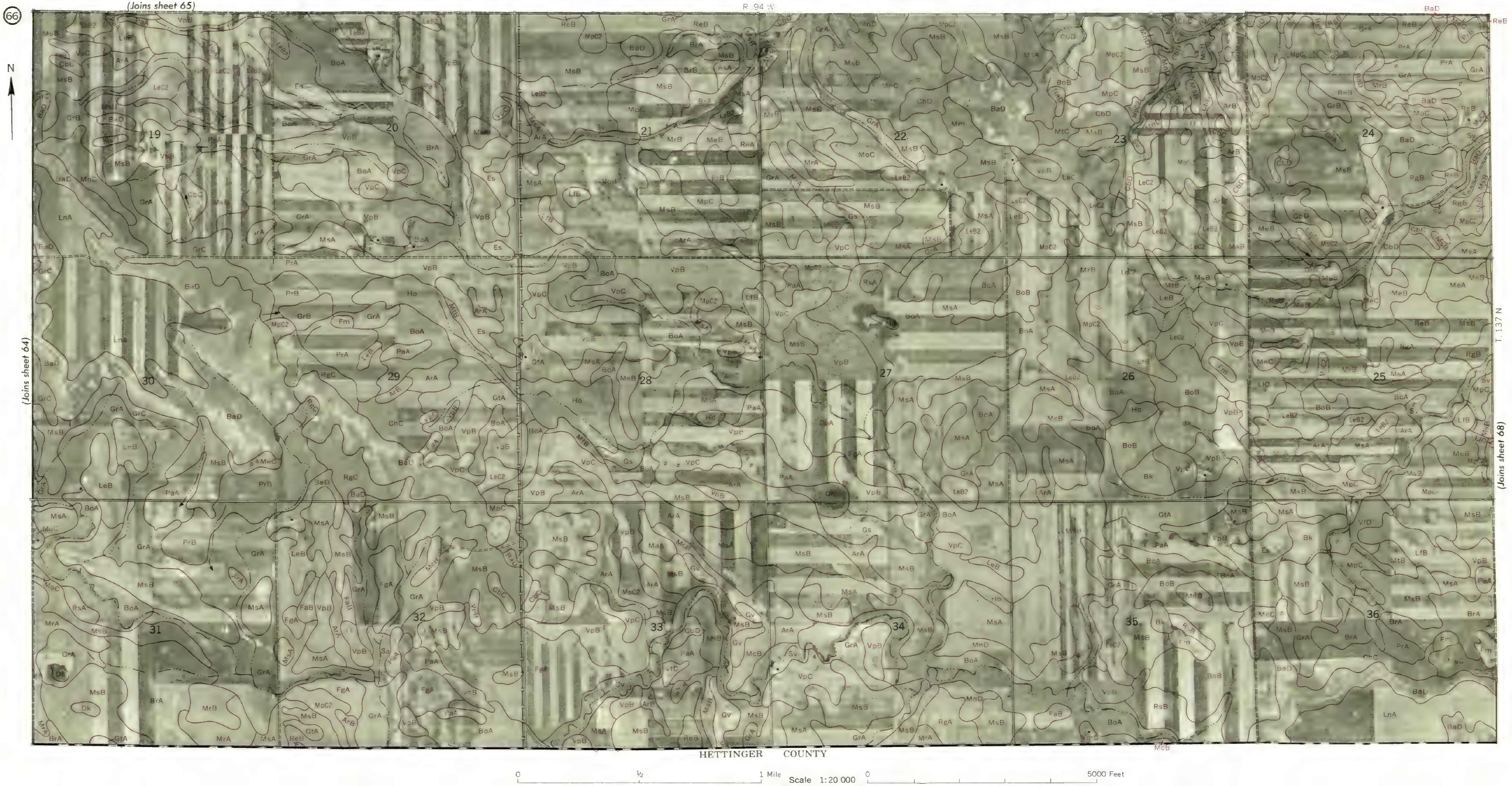


0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture and the North Dakota Agricultural Experiment Station.
Range, township, and section corners shown on this map are indefinite.

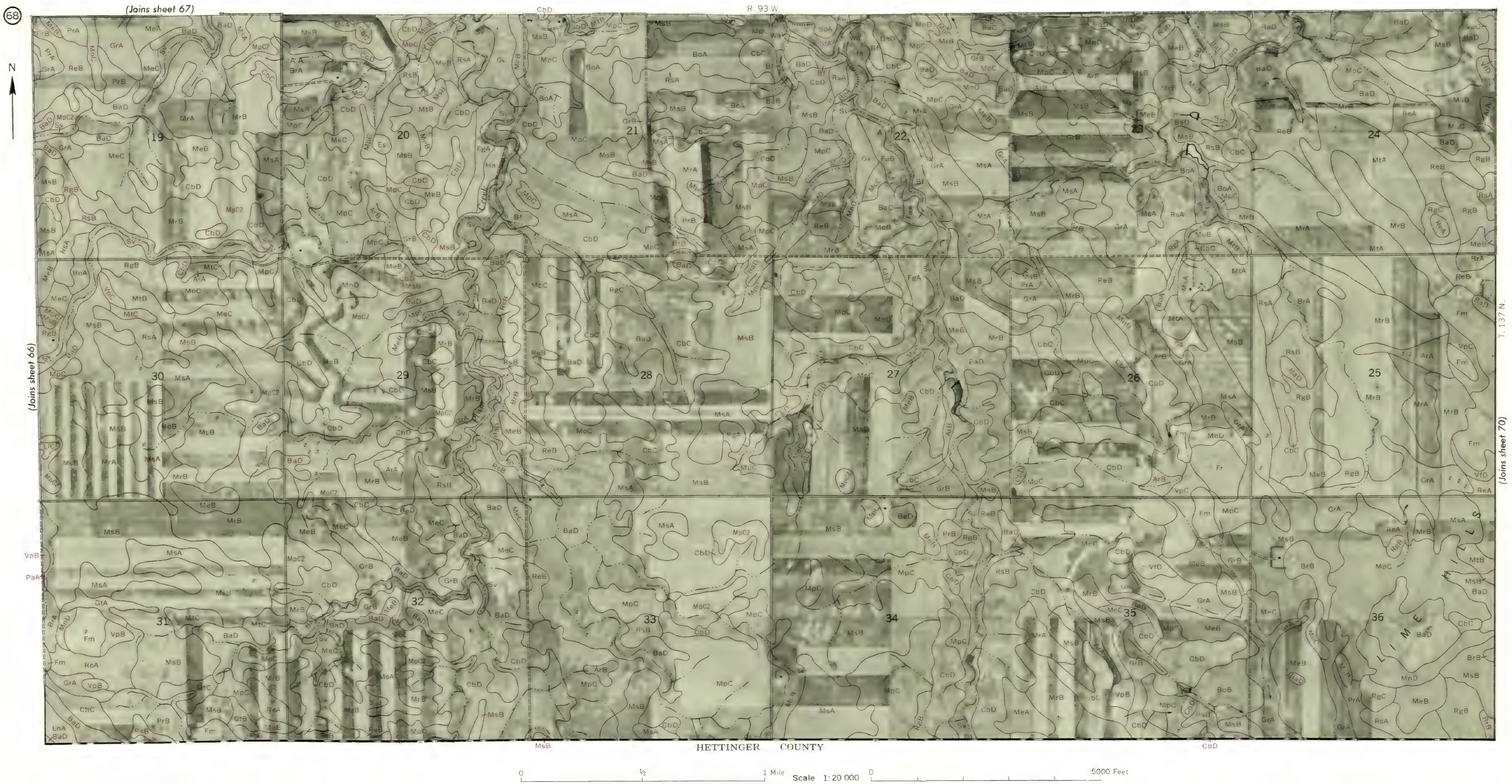


0 ½ 1 Mile Scale 1:20 000 0 5000 Feet


66
(Joins sheet 65)
R. 94 W.
N
(Joins sheet 64)
(Joins sheet 68)
T. 137 N.
HETTINGER COUNTY
0
½
1 Mile
Scale 1:20 000
0
5000 Feet

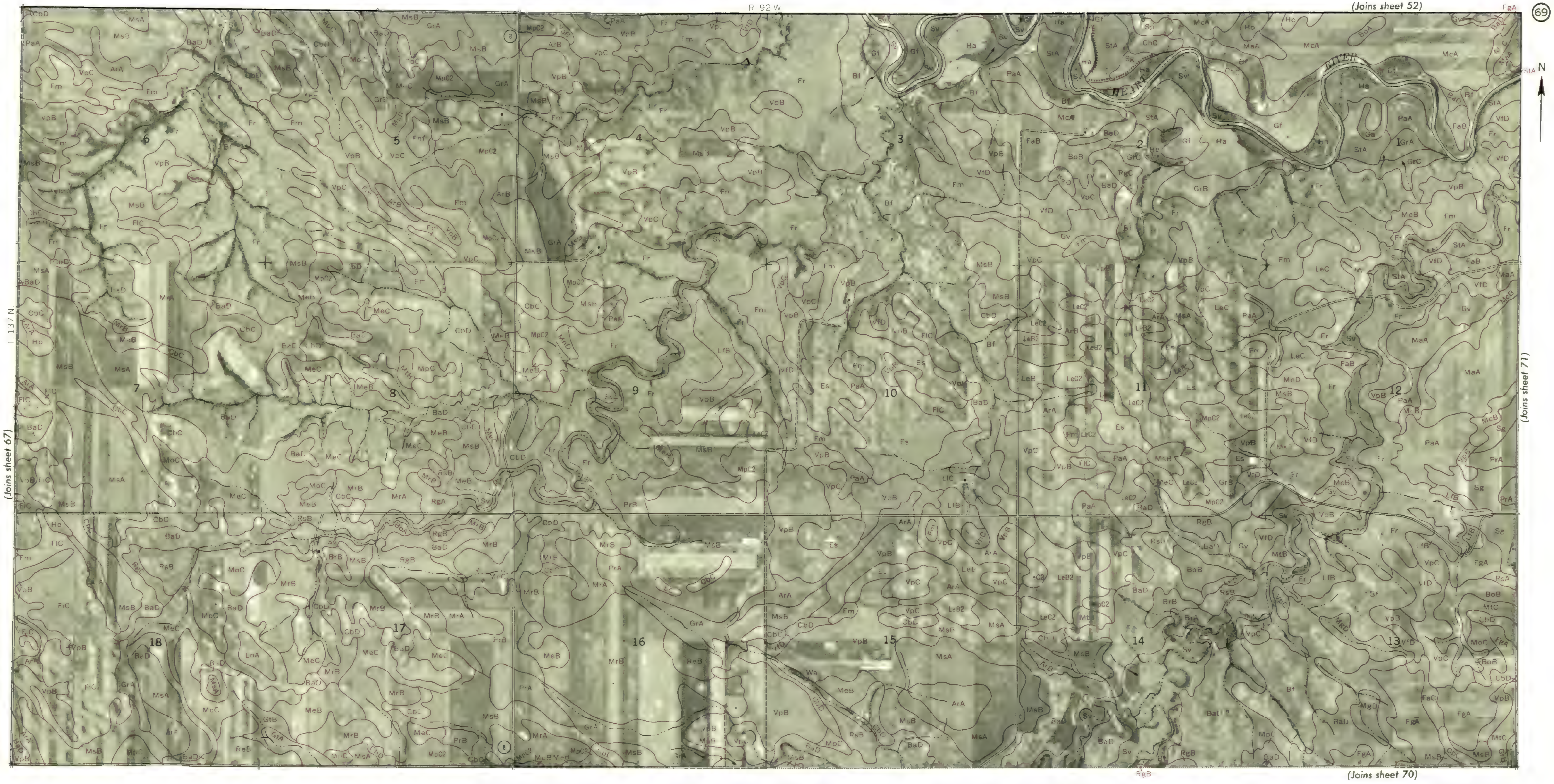
This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the North Dakota Agricultural Experiment Station. Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

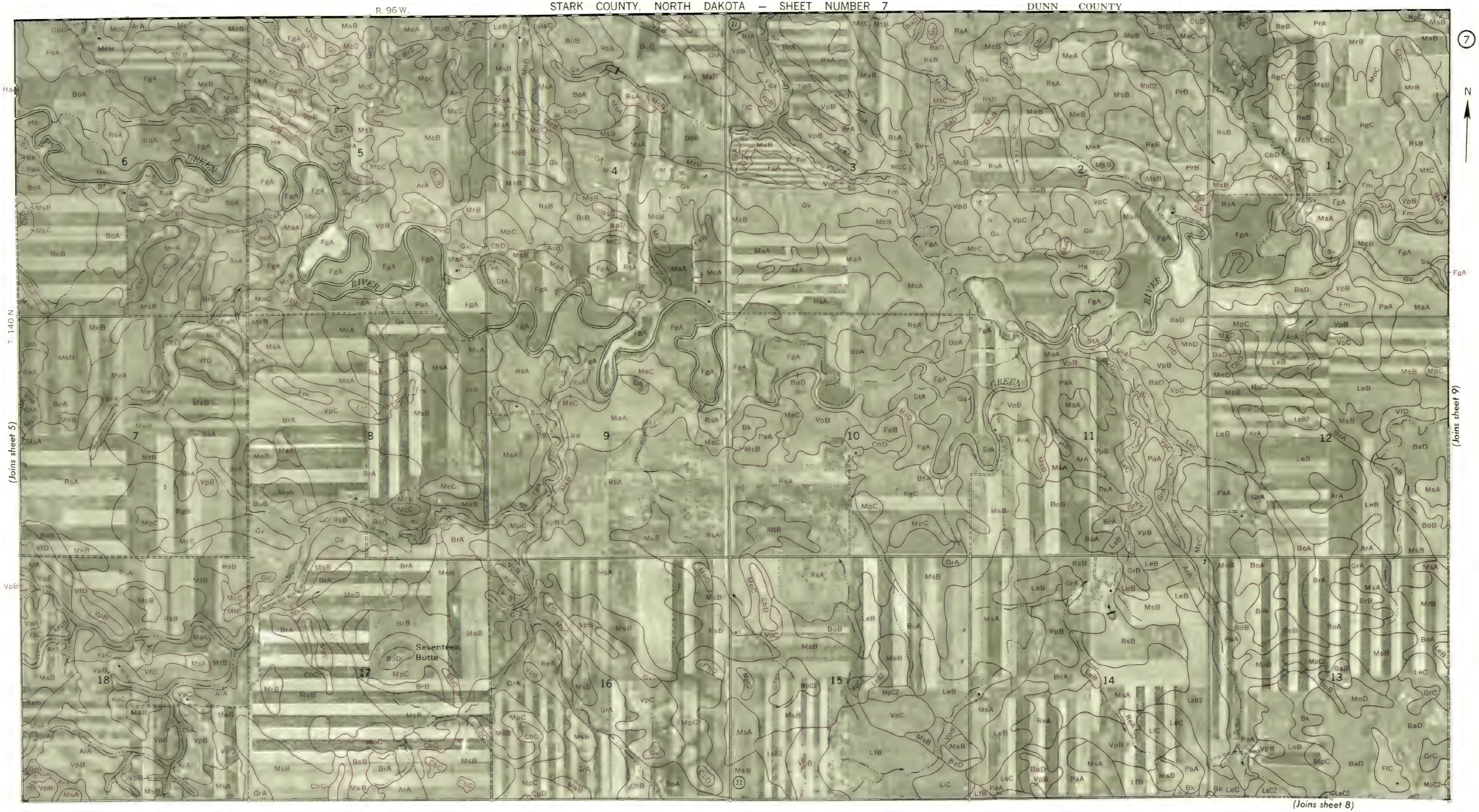

68
(Joins sheet 67)
R. 93 W.
N
(Joins sheet 66)
(Joins sheet 70)
T. 137 N.
19
20
21
22
23
24
30
29
28
27
26
25
31
32
33
34
35
36
LIME HILLS
HETTINGER COUNTY
0
½
1 Mile
Scale 1:20 000
0
5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the North Dakota Agricultural Experiment Station

Range, township, and section corners shown on this map are indefinite.

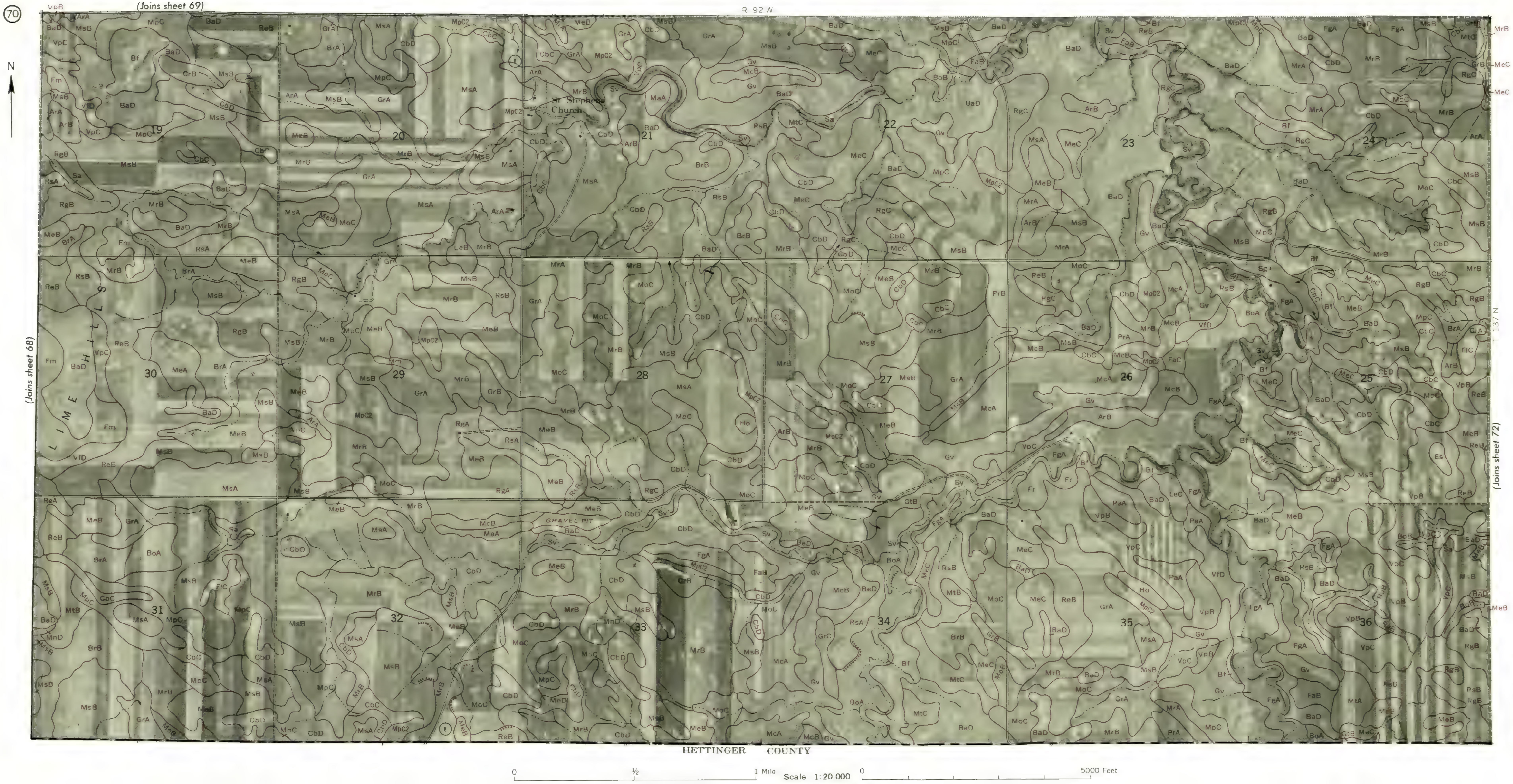


0 ½ 1 Mile Scale 1:20 000 0 5000 Feet



5000 Feet
0
1 Mile Scale 1:20 000
½
0

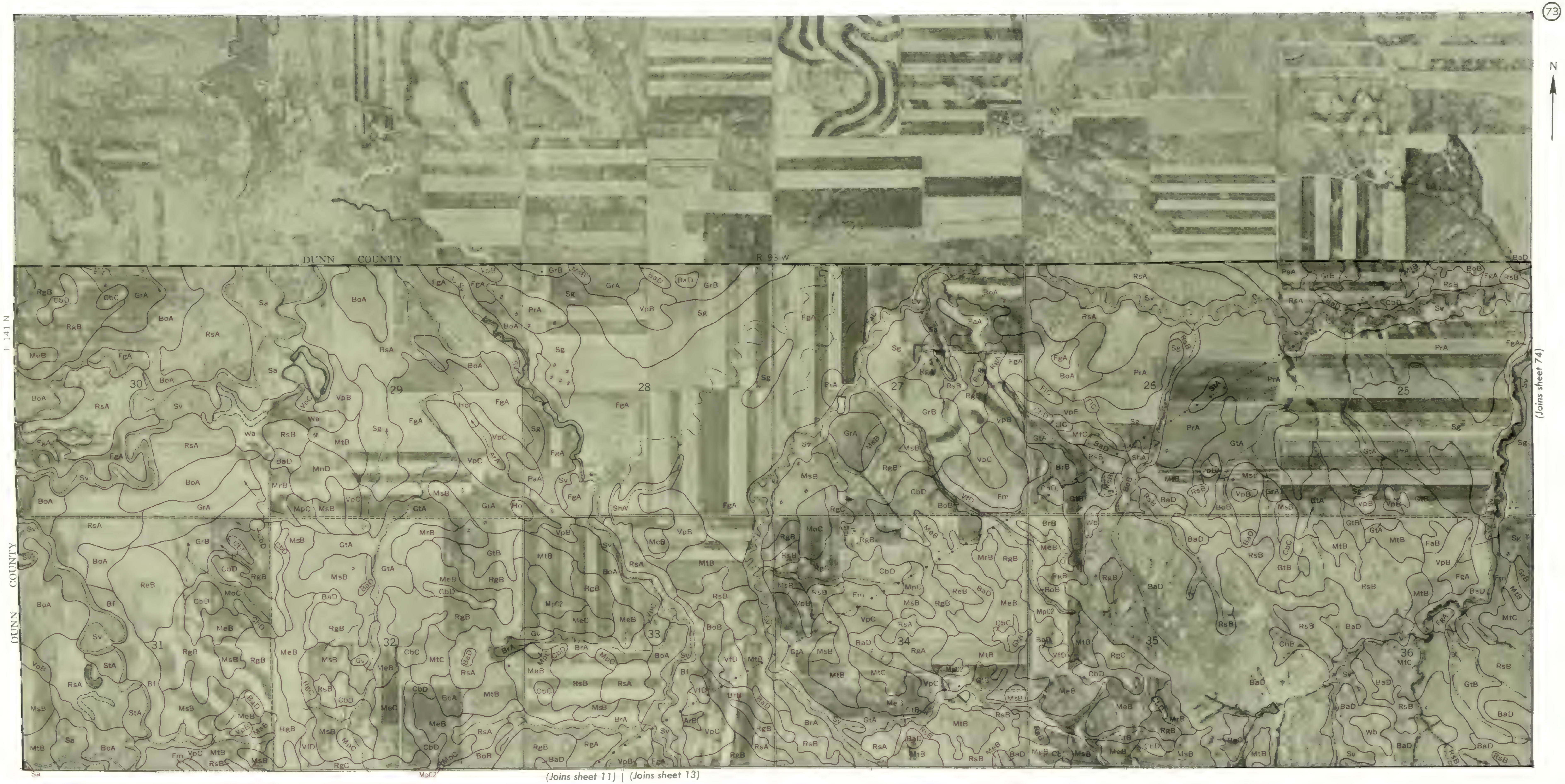
This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Range, township, and section corners shown on this map are indefinite.


70
(Joins sheet 69)
R 92 W
N
St Stephens Church
(Joins sheet 68)
LIME HILLS
(Joins sheet 72)
T 137 N
GRAVEL PIT
19
20
21
22
23
24
30
29
28
27
26
25
31
32
33
34
35
36
HETTINGER COUNTY
0
½
1 Mile
Scale 1:20 000
0
5000 Feet

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Range, township, and section corners shown on this map are indefinite.

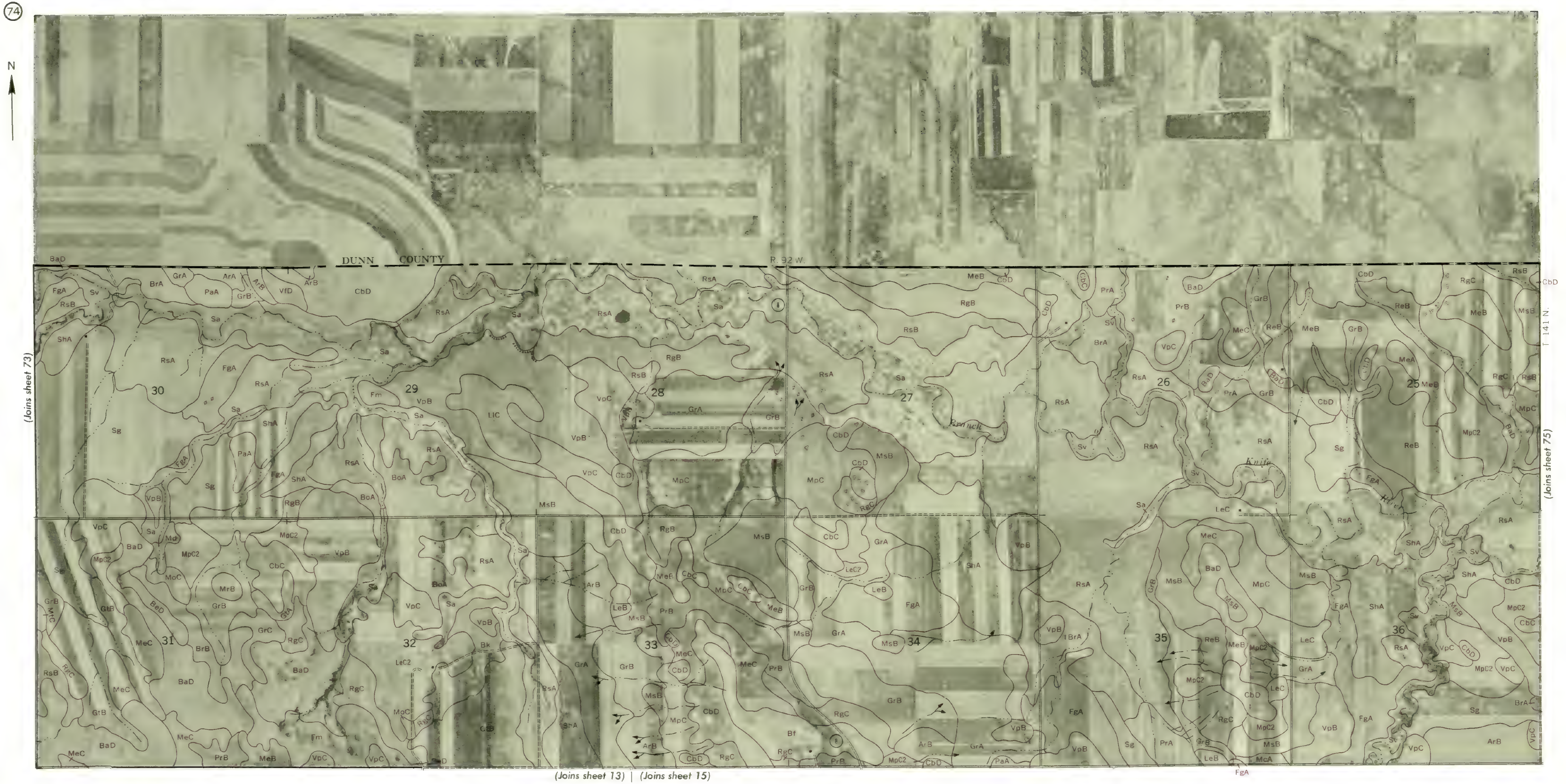
0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet



Range, township, and section corners shown on this map are indefinite.

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

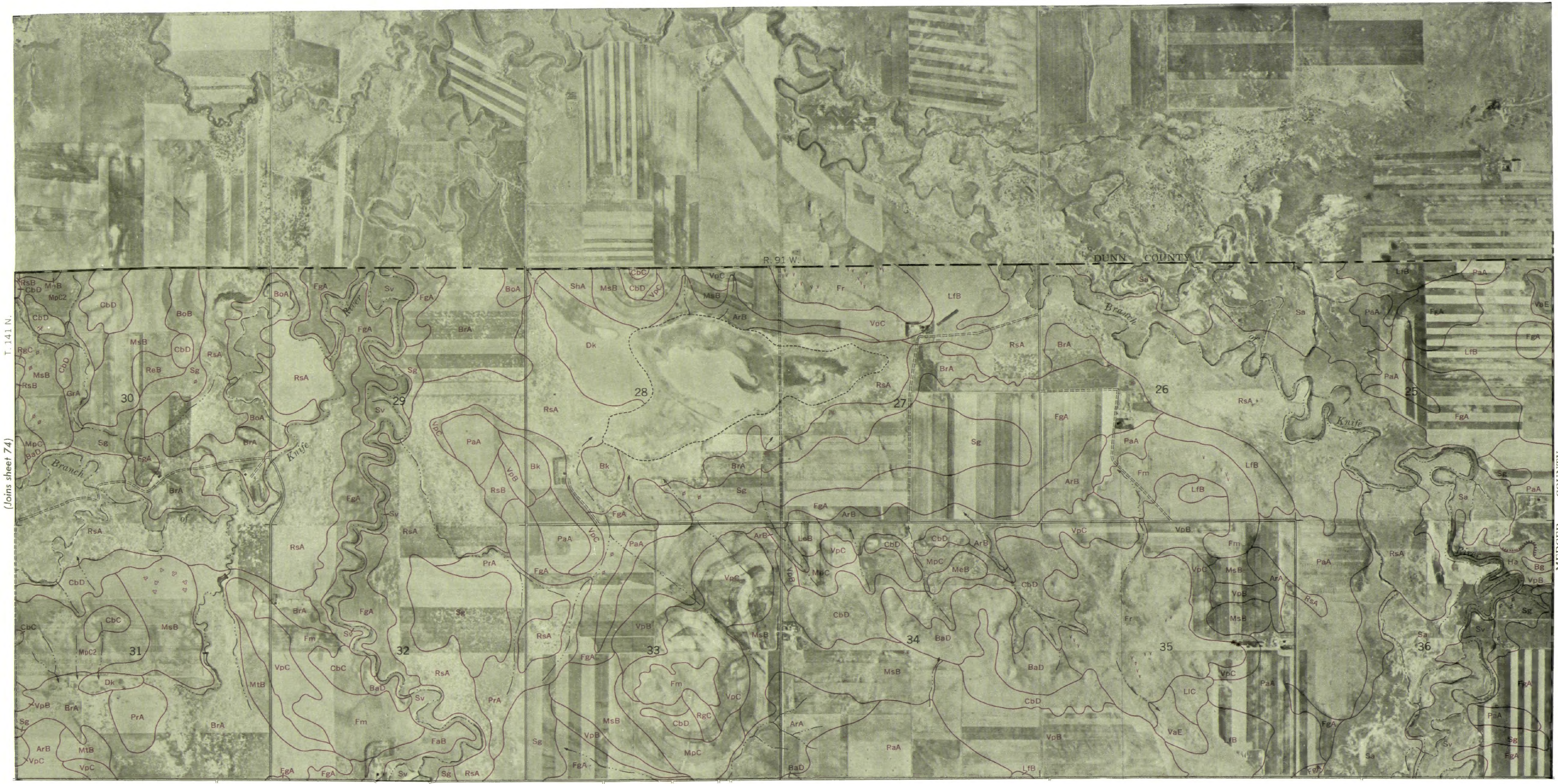


0 ½ 1 Mile Scale 1:20 000 0 5000 Feet

75

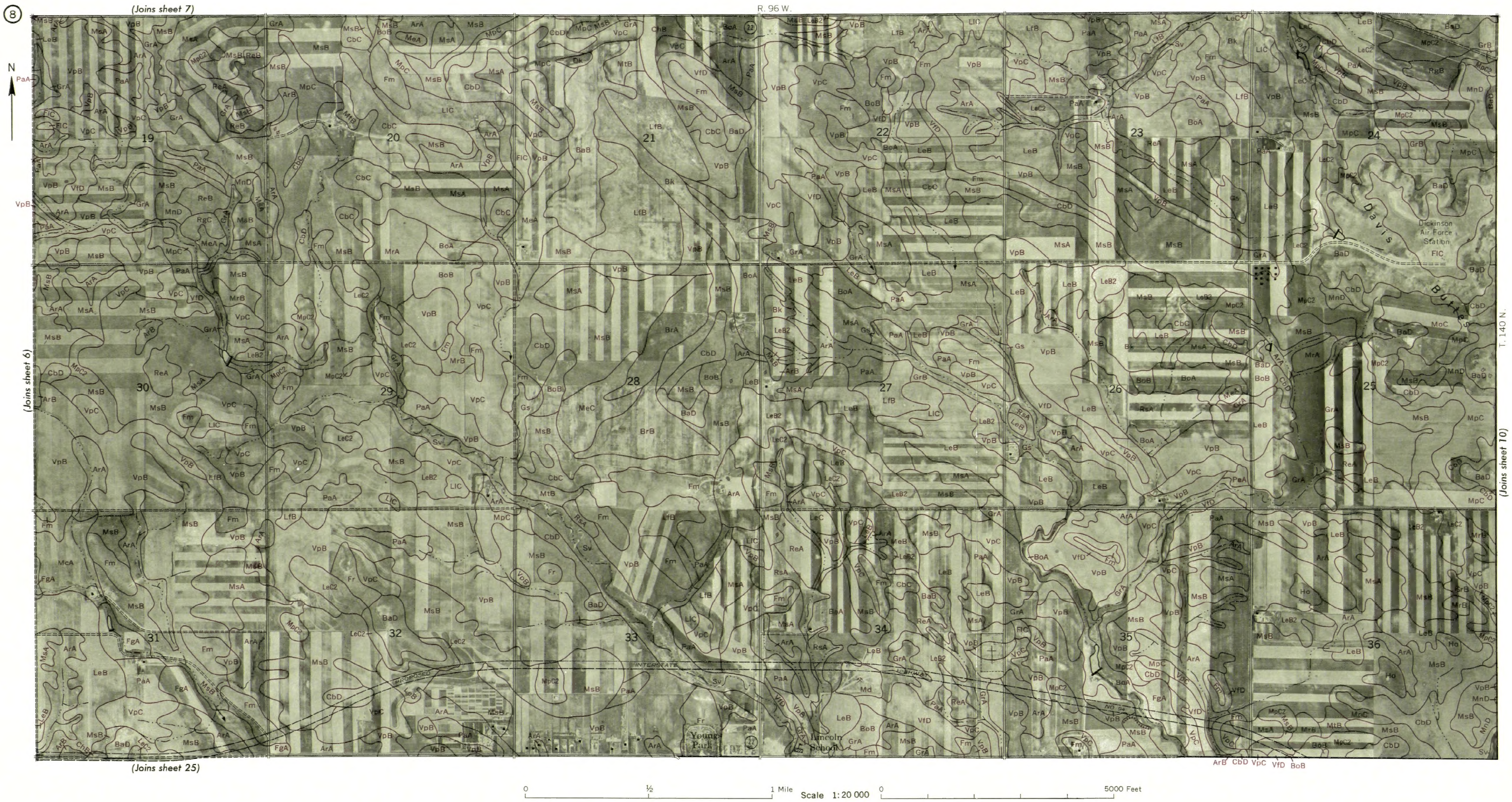
N

This map is one of a set compiled in 1965 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the North Dakota Agricultural Experiment Station.
Range, township, and section corners shown on this map are indefinite.



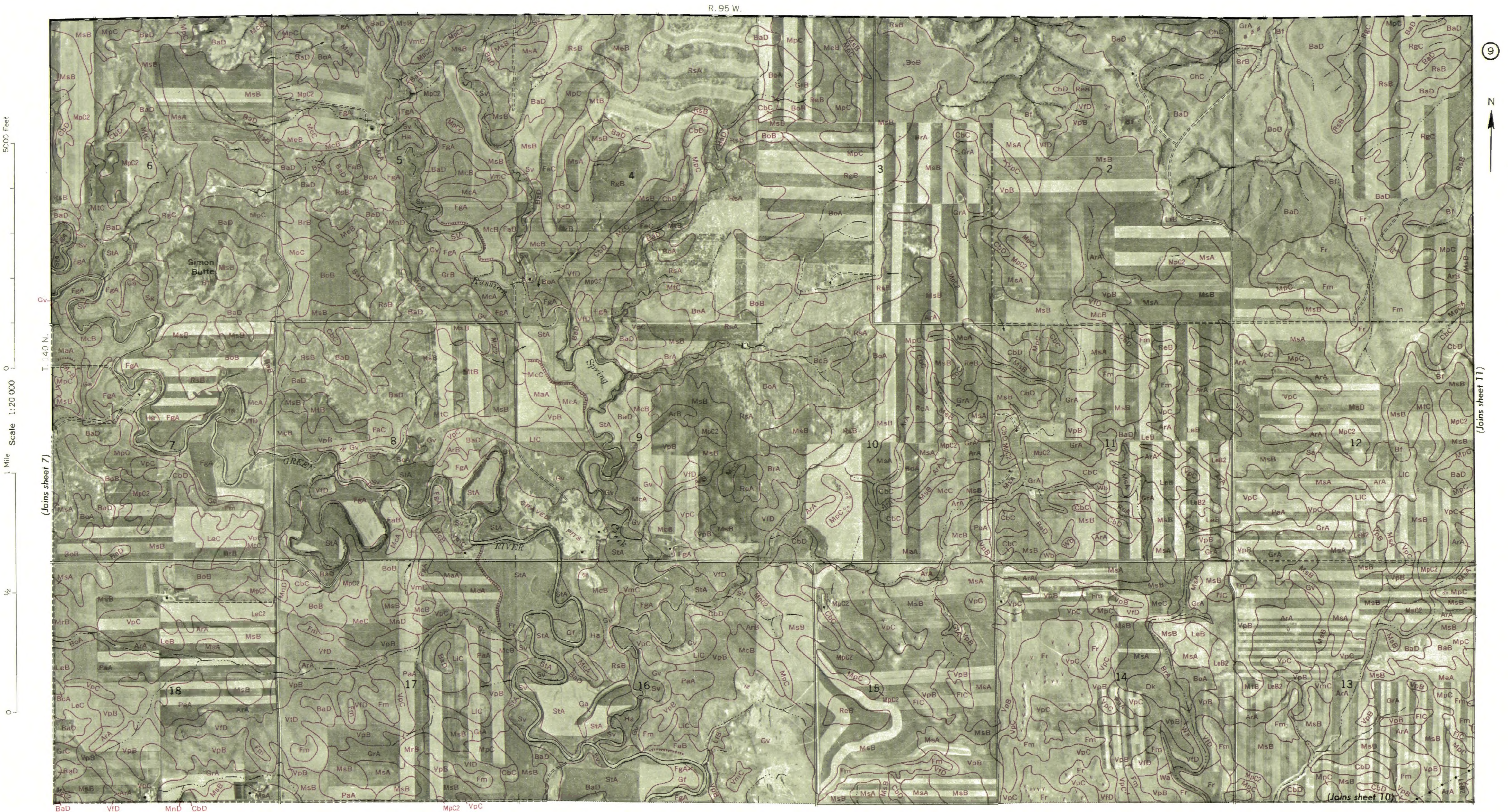
(Joins sheet 15) (Joins sheet 17)

0 ½ 1 Mile Scale 1:20 000 0 5000 Feet


8
(Joins sheet 7)
R. 96 W.
N
(Joins sheet 6)
(Joins sheet 10)
(Joins sheet 25)
T. 140 N.
Dickinson Air Force Station
Davis Buttes
Youngs Park
Lincoln School
Interstate
0
½
1 Mile
Scale 1: 20 000
0
5000 Feet

STARK COUNTY, NORTH DAKOTA — SHEET NUMBER 9

Scale 1:20 000



GUIDE TO MAPPING UNITS, CAPABILITY UNITS, AND RANGE SITES

[Table 1, p. 6, gives the approximate acreage and proportionate extent of the soils, and table 2, p. 48, gives the estimated average acre yields of crops. Facts about the management of windbreaks are given in the section beginning on p. 55, and facts about uses of the soils for engineering are given in the section beginning on p. 56. Dashes indicate the soil was not placed in the group specified]

Map symbol	Mapping unit	Described on page	Capability unit Symbol	Capability unit Page	Range site Name	Range site Page
ArA	Arnegard loam, level	7	IIc-6	39	Silty	52
ArB	Arnegard loam, gently sloping	7	IIIe-6	41	Silty	52
BaB	Bainville and Midway soils, undulating	8	VIe-TSi	45	Thin Silty	53
BaD	Bainville and Midway soils, steep	8	VIe-TSi	45	Thin Silty	53
Bd	Bainville and Midway stony soils	8	VIe-TSi	45	Thin Silty	53
BeD	Bainville-Rhoades complex, strongly sloping	8	VIs-Ps	46	Panspot	54
Bf	Bainville-Shale outcrop complex	9	VIIs-TB	46	Thin Breaks	54
Bg	Banks and Glendive soils	9	VIe-Sa	45	Sands	51
Bk	Beckton complex	10	IIIe-3P	40	Sandy	52
BoA	Belfield-Rhoades loams, level	10	IIIs-5P	42	Silty	52
BoB	Belfield-Rhoades loams, gently sloping	10	IIIe-6P	41	Silty	52
BrA	Belfield-Rhoades silty clay loams, level	11	IIIs-5P	42	Clayey	53
BrB	Belfield-Rhoades silty clay loams, gently sloping	11	IIIe-6P	41	Clayey	53
CbC	Chama-Bainville loams, sloping	11	IVe-4L	43	Silty	52
CbD	Chama-Bainville loams, strongly sloping	12	VIe-TSi	45	Thin Silty	53
ChB	Cherry silty clay loam, gently sloping	12	IIIe-4	41	Clayey	53
ChC	Cherry silty clay loam, sloping	12	IIIe-4	41	Clayey	53
Co	Colvin silt loam	13	Vw-Sb	44	Subirrigated	50
Dk	Dimmick clay	13	IIIw-4, if drained Vw-WL, if un-drained	43 44	Wetland	50
Es	Eroded sandy land	14	VIe-Sa	45	Sands	51
FaB	Farland silt loam, gently sloping	14	IIIe-6	41	Silty	52
FaC	Farland silt loam, sloping	15	IIIe-6	41	Silty	52
FgA	Farland, Arnegard and Grail silt loams, level	15	IIc-6	39	Silty	52
FlC	Flasher sandy loam, sloping	15	VIe-TSy	45	Thin Sandy	53
Fm	Flasher complex	15	VIe-TSy	45	Thin Sandy	53
Fr	Flasher-Rock outcrop complex	16	VIIs-TB	46	Thin Breaks	54
Ga	Gallatin clay loam	16	Vw-Ov	44	Overflow	51
Gf	Glendive fine sandy loam	17	IIIe-3	40	Sandy	52
GrA	Grail silty clay loam, level	17	IIc-6	39	Silty	52
GrB	Grail silty clay loam, gently sloping	18	IIIe-6	41	Silty	52
GrC	Grail silty clay loam, sloping	18	IIIe-6	41	Silty	52
Gs	Grail soils, saline	18	IIIws-4	43	Subirrigated	50
GtA	Grail-Rhoades silty clay loams, level	18	IIIs-5P	42	Silty	52
GtB	Grail-Rhoades silty clay loams, gently sloping	18	IIIe-6P	41	Silty	52
Gv	Gravelly land	19	VIIs-SwG	46	Shallow to gravel	53
Ha	Havre loam	19	IIe-5	40	Silty	52
He	Havre silty clay loam	19	IIe-4	39	Clayey	53
Ho	Hoven soils	20	IVws-4	44	Overflow	51
LeB	Lefor fine sandy loam, undulating	20	IIIe-3M	40	Sandy	52
LeB2	Lefor fine sandy loam, undulating, eroded	21	IIIe-3M	40	Sandy	52
LeC	Lefor fine sandy loam, sloping	21	IVe-3	43	Sandy	52
LeC2	Lefor fine sandy loam, sloping, eroded	21	IVe-3	43	Sandy	52
LfB	Lihen loamy fine sand, undulating	21	IVe-2	43	Sands	51
LlC	Lihen-Flasher loamy fine sands, rolling	22	VIe-Sa	45	Sands	51
LnA	Little Horn and Duncom soils, level	22	IIIs-6R	43	Silty	52
LnB	Little Horn and Duncom soils, gently sloping	22	IIIs-6R	43	Silty	52
MaA	Manning loam, level	23	IIe-5	40	Silty	52
McA	Manning fine sandy loam, level	23	IIIes-3	41	Sandy	52
McB	Manning fine sandy loam, gently sloping	23	IIIes-3	41	Sandy	52
McC	Manning fine sandy loam, sloping	24	IIIes-3	41	Sandy	52
Md	Mine dumps	24	VIIIs-1	47	-----	--
MeA	Moreau silty clay, level	24	IIIse-4	42	Clayey	53
MeB	Moreau silty clay, gently sloping	25	IIIes-4	42	Clayey	53
MeC	Moreau silty clay, sloping	25	IIIes-4	42	Clayey	53
Mf	Moreau stony soils	25	VIs-Cy	45	Clayey	53
MgD	Moreau-Midway silty clays, strongly sloping	25	VIe-Cy	45	Clayey	53
Mh	Moreau-Midway-Rock outcrop complex	26	VIIs-TB	46	Thin Breaks	54
Mk	Moreau-Rock outcrop complex	25	VIe-Cy	45	Clayey	53
Mm	Morton stony loam	26	VIs-Si	46	Silty	52
MnD	Morton-Bainville complex, strongly sloping	26	IVe-4L	43	Silty	52
MoC	Morton-Chama clay loams, sloping	26	IIIe-6	41	Silty	52
MpC	Morton-Chama silt loams, sloping	27	IIIe-6	41	Silty	52
MpC2	Morton-Chama silt loams, sloping, eroded	27	IVe-4L	43	Silty	52
MrA	Morton and Farland clay loams, level	27	IIc-6	39	Silty	52
MrB	Morton and Farland clay loams, gently sloping	27	IIIe-6	41	Silty	52
MsA	Morton and Farland silt loams, level	27	IIc-6	39	Silty	52
MsB	Morton and Farland silt loams, gently sloping	28	IIIe-6	41	Silty	52
MtA	Morton-Rhoades loams, level	28	IIIs-5P	42	Silty	52
MtB	Morton-Rhoades loams, gently sloping	28	IIIe-6P	41	Silty	52
MtC	Morton-Rhoades loams, sloping	28	IIIe-6P	41	Silty	52
MtC2	Morton-Rhoades loams, sloping, eroded	28	IVe-4P	44	Silty	52
PaA	Parshall fine sandy loam, level	29	IIIe-3	40	Sandy	52
PrA	Promise silty clay, level	29	IIe-4	39	Clayey	53
PrB	Promise silty clay, gently sloping	30	IIIe-4	41	Clayey	53
ReA	Regent silty clay loam, level	31	IIe-4	39	Clayey	53
ReB	Regent silty clay loam, gently sloping	31	IIIe-4	41	Clayey	53
RgA	Regent-Moreau silty clay loams, level	31	IIIse-4	42	Clayey	53
RgB	Regent-Moreau silty clay loams, gently sloping	31	IIIes-4	42	Clayey	53
RgC	Regent-Moreau silty clay loams, sloping	31	IVe-4P	44	Clayey	53
RsA	Rhoades and Belfield soils, level	32	VIs-Ps	46	Panspot	54
RsB	Rhoades and Belfield soils, gently sloping	32	VIs-Ps	46	Panspot	54
Sa	Saline alluvial land	32	VIs-SS	46	Saline Subirrigated	51
Sg	Savage silty clay loam	33	IIe-4	39	Clayey	53
ShA	Savage-Rhoades silty clay loams, level	33	IIIs-5P	42	Clayey	53
Sm	Searing loam	34	IIIes-5	42	Silty	52
So	Shale outcrop-Bainville complex	34	VIIs-BL	46	Badlands	54
Sp	Shale outcrop	34	VIIIs-1	47	--------	--
StA	Straw loam, level	35	IIc-6	39	Silty	52
Sv	Straw and Havre soils, channeled	35	VIe-Si	45	Silty	52
VaE	Valentine fine sand, hilly	36	VIIe-CS	46	Choppy Sands	52
VfD	Vebar-Flasher fine sandy loams, strongly sloping	36	IVe-3	43	Sandy	52
VmC	Vebar-Manning fine sandy loams, sloping	36	IVe-3	43	Sandy	52
VpB	Vebar-Parshall fine sandy loams, undulating	36	IIIe-3	40	Sandy	52
VpC	Vebar-Parshall fine sandy loams, sloping	37	IVe-3	43	Sandy	52
Wa	Wet alluvial land	38	Vw-WL	44	Wetland	50
Wb	Wibaux soils	38	VIIs-VS	47	Very Shallow	54

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